The Ballona Wetlands Ecological Reserve Baseline Assessment Program 2010-2011 Final Report

Ballona Wetlands Ecological Reserve, Los Angeles, California
Santa Monica Bay Restoration Commission

Prepared for: California State Coastal Conservancy
California Department of Fish and Game

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Photo credit: E. Tuttle

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Cover:

"Ballona salt pan, pickleweed and ponded rainwater"

Photograph by Jonathan Coffin

Photo credit: I. Medel

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bay restoration commission
STEWARDS OF SANTA MONICA BAY

CALIFORNIA
DEPARTMENT OF
FISH&GAME

State of California
Coastal Conservancy

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ABBREVIATION TABLE

°C – degrees Celsius
µg/kg – micrograms per killigram
µg/L – micrograms per liter
BAP – Ballona Wetlands Ecological Reserve Baseline Assessment Program; Baseline Assessment Program
Bay – Santa Monica Bay
Bight '08 - Southern California Bight Project 2008
BOLD – Ballona Outdoor Learning and Discovery
BWER – Ballona Wetlands Ecological Reserve; Ballona Wetlands
CalEPA – California Environmental Protection Agency
Cal-IPC – California Invasive Plant Council
CDFG – California Department of Fish and Game
CEQA – California Environmental Quality Act
cfs – cubic feet per second
cm – centimeters
CNDDB – California Natural Diversity Database
CNPS – California Native Plant Society
CRAM – California Rapid Assessment Program
CSC – California Species of Special Concern
CTR – California Toxics Rule
CWA – Clean Water Act
DDT – dichlorodiphenyl trichloroethane
DO – dissolved oxygen
DPW – Department of Public Works
DTPA – diethylene triamine pentoacetic acid
EAP – Early Action Plan
ECe – Electrical Conductivity
Eco-SSL – Environmental Protection Agency's Ecological Soil Screening Level
EIR – Environmental Impact Report
EPA – Environmental Protection Agency, United States Environmental Protection Agency
ERL – effect range low
ERM – effect range median
FBW – Friends of the Ballona Wetlands
FIB – fecal indicator bacteria
Fish/m^3 – number of fish per cubic meter (density)
FWM – Ballona Freshwater Marsh
GIN – Green Info Network
GIS – geographic information system
GPS – global positioning system
HBC – Hawks Biological Consulting
HDPE – high density polyethylene
ITIS – Integrated Taxonomic Information System
IWRAP – Integrated Wetland Regional Assessment Monitoring Program
KBC – Keane Biological Consulting
LA City – the City of Los Angeles; City of LA
LADPW – Los Angeles Department of Public
LARWQCB – Los Angeles Regional Water Quality Control Board
LAX – Los Angeles International Airport

LISST - *in situ* laser refractometry
LMU – Loyola Marymount University
m – meters
MEC – Managing Environmental Concerns Analytical Systems, now Weston Solutions, Inc.
mg/kg – milligrams per kilogram
mg/L – milligrams per liter
mL – milliliter
MLLW – mean lower low water
MPN – most probable number
MSL – mean sea level
NO^{-2}, NO_2 – nitrite
NO^{-3}, NO_3 – nitrate
NOAA – National Oceanic and Atmospheric Administration
NTU – Nephelometric Turbidity Units
PAH – polycyclic aromatic hydrocarbons
PCB – polychlorinated biphenyl
PO_4 – phosphate
ppb – parts per billion
ppm – parts per million
ppt – parts per thousand
PVC – polyvinyl chloride
PWA – Phillip Williams and Associates
QAQC – Quality Assurance and Quality Control
SAV – submerged aquatic vegetation
SCAMIT – Southern California Association of Marine Invertebrate Taxonomists
SCC, CCC – California State Coastal Conservancy
SCCWRP – Southern California Coastal Water Research Project
SE – standard error
SMBRC – Santa Monica Bay Restoration Commission
SMBRF – Santa Monica Bay Restoration Foundation
SONGS – San Onofre Nuclear Generating Station
sp – species
spp – multiple species
SRT – self-regulating tide gate
SSAR – Society for the Study of Amphibians and Reptiles
SWAMP – Surface Water Ambient Monitoring Program
SWRCB – State Water Resources Control Board
TDS – total dissolved solids
TMDL – Total Maximum Daily Load
TOC – total organic carbon
TSM – total suspended matter
TSS – total suspended solids
US EPA – United States Environmental Protection Agency, Environmental Protection Agency
USACE – United States Army Corps of Engineers
USFWS – United States Fish and Wildlife Service
USGS – United States Geological Survey
WRP – Southern California Wetland Recovery Project
YSI – Yellowsprings Instrument

EXECUTIVE SUMMARY

The mission of the Santa Monica Bay Restoration Commission (SMBRC) is to restore and enhance the Santa Monica Bay (Bay) through actions and partnerships that improve water quality, conserve and rehabilitate natural resources, and protect the Bay's benefits and values. The SMBRC is charged with implementing the Bay Restoration Plan, a stakeholder-developed plan that describes goals, objectives, and milestones to address the environmental problems facing the Bay and the Bay's watersheds. Scientific monitoring of the Bay's natural resources and restoring coastal wetlands are important parts of the Bay Restoration Plan.

In September 2011, the SMBRC completed the second year of baseline assessment surveys at the Ballona Wetlands Ecological Reserve (BWER). The comprehensive surveys were developed in partnership with the California Department of Fish and Game and the California State Coastal Conservancy to assess the condition of the BWER and inform the state's wetlands restoration planning. The surveys incorporated monitoring and assessment of biological, chemical, and physical components of the BWER ecosystem. Vegetation, seed core, terrestrial invertebrate, and elevation surveys were conducted on permanent transects randomly located throughout all habitat types at the BWER. Additional biological data collected included surveys for small and large mammals, vertebrate mortality along roads, herpetofauna, ichthyofauna, benthic invertebrates, birds, and submerged aquatic vegetation (Table 1). Water quality data collected included dissolved metals, fecal indicator bacteria, nutrients, and additional parameters. Sediment quality data included trace metals, amphipod toxicity, grain size, and total organic carbon. This document provides a summary of the data collected during the second year of the Baseline Assessment Program (BAP) survey of the BWER.

CHEMICAL ANALYSES

Water quality surveys were a critical component of the BAP. Comprehensive temporal and spatial data on the distributions of metals, nutrients (nitrates, nitrites and orthophosphates), and fecal indicator bacteria [FIB (i.e. total coliform, *E. coli*, and enterococci)] were obtained through water column stratification studies in the second baseline year. Overall, water quality sampling showed high levels of FIB, and indicated that the tidal portion of the BWER generally functions as a sink, rather than a source of bacteria, with higher bacteria numbers in the Ballona Creek estuary than in the tide channels. Bacteria levels at most sites consistently exceeded Total Maximum Daily Load (TMDL) levels, sometimes by several orders of magnitude. Nutrient levels overall were low.

Dissolved metals in water were tested once in January 2011 at seven stations, to capture one-time wet season values. Dissolved metals exceeding acute toxicity levels (USEPA 2009) at multiple stations included: zinc, copper (all stations), cadmium, selenium, and tin. Additionally, dissolved metals exceeding chronic toxicity levels (USEPA 2009) at multiple stations included: iron, boron (all stations), cadmium, cobalt, and lead.

Marine sediment surveys at seven stations were assessed in the first baseline year using a gentle extraction method (extractable ammonium bicarbonate diethylene triamine pentoacetic acid or DTPA), to assess bioavailability of trace metals within the sediments. Marine sediment surveys were assessed during the second baseline year using an acid digestion method to evaluate the soluble, exchangeable, and bulk mineral forms of the metals for comparison. Results during the first year indicated an exceedance [evaluated using ERL limits (USEPA 1996)] at one station during the first baseline year (BW8). All stations in the second baseline year trace metals and elements results had at least one metal exceedance using the strong acid digestion. Stations BW5, BW7, and BW9 exceeded limits for all elements evaluated against ERLs (i.e. arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver, and zinc).

Carbon sequestration and analysis of stratification of carbon and other organic matter in the soil was scheduled to be completed, but due to permit restrictions, these surveys were not conducted.

VEGETATION

The objective of the vegetation surveys was to determine average percent cover of species using both transect-level and habitat-level assessments. Vegetation cover surveys were conducted on randomly allocated transects throughout each habitat. 122 vegetation transects were surveyed in the second baseline year including 51 in the salt marsh habitat types and 71 in non-salt marsh habitat types. Several methods were used to assess percent cover and diversity because of the differing conditions across multiple habitats (e.g. plant height and density, species diversity, topography). The tidally influenced lower marsh habitats were surveyed via laser quadrat method. Percent cover was evaluated using size classes to survey the upland dune, scrub, and grassland habitats. In addition to vegetation surveys, terrestrial and aerial invertebrate surveys were conducted on a subset of transects to evaluate ecosystem-level function of the habitat.

All transects in Area C had greater than 10% non-native vegetative cover; nine of 13 transects had greater than 50% non-native cover (69.2% of the Area C transects). All transects in Area A except for two had greater than 10% non-native vegetative cover; two additional transects had cover between 11-25%, and the rest (26 transects) had greater than 26% non-native cover. Conversely, the salt marsh habitats had predominantly native cover. The muted tidal marsh of Area B had a higher percent cover of native plant species than either Area A or C.

Results for the salt marsh habitats indicated that the low marsh habitat type had the highest average percent cover of native species at 92.5 ± 2.6%, followed by the mid marsh (77.7 ± 8.2%) and the high marsh (65.1 ± 8.8%). Results for the non-salt marsh habitats indicated that the brackish and freshwater habitats had a higher average percent cover of native species (66.6 ± 8.5% and 60.5 ± 11.8%, respectively) than non-native species; the brackish marsh habitat had the highest average native percent cover of the non-salt marsh habitats evaluated.

Species lists and relative abundances were tallied and analyzed across several variables, including habitat, area, and native or non-native classifications. Results from the second year of the BAP indicated overall dominant cover of non-native plant species in the upland habitats and dominant cover of native species within the marsh habitats. The most common non-native species in upland areas included: black mustard (*Brassica nigra*), crown daisy (*Glebionis coronaria*), and iceplant (*Carpobrotus edulis*). The most common native species in the tidal marsh habitats included: common pickleweed (*Salicornia pacifica*), fleshy jaumea (*Jaumea carnosa*), saltgrass (*Distichlis spicata*), alkali weed (*Cressa truxillensis*), and Parish's pickleweed (*Arthrocnemum subterminale*).

Nineteen plant species germinated in the soil cores; six were native species representing 45% of the total number of germinated seedlings on transects. *S. pacifica* represented 42% of the seedlings on the vegetation transects and 47% of the seedlings on the channel bank transects.

Overall, the pattern of percent cover of native species and non-native species in each habitat was similar between both baseline years.

VERTEBRATES

The Ballona Wetlands region, and the BWER, has suffered a decline in native vertebrate populations, a reduction in species ranges, and an increase in introduced species throughout the last century (Friesen et al. 1981). Up-to-date comprehensive vertebrate surveys are imperative to establish current ranges and species presences within the BWER.

Ichthyofauna

Ichthyofauna sampling occurred three times during the second baseline assessment year: September 2010, April 2011, and July 2011. Sampling methods employed a combination of blocking nets and beach seines, and shrimp trawls. The blocking net and beach seine surveys were conducted at six permanent stations within the BWER: three in the Fiji Ditch in Area A, and three in the tidal channels within Area B. These stations were a subset of the invertebrate, sediment, and water quality sampling stations. Single-day shrimp trawl surveys were conducted during July and September 2011 in Ballona Creek following protocols from the first baseline year.

The beach seine surveys identified a total of seven native species: topsmelt (*Atherinops affinis*), arrow goby (*Clevelandia ios*), California killifish (*Fundulus parvipinnis*), longjaw mudsucker (*Gillichthys mirabilis*), diamond turbot (*Hypsopsetta guttulata*), Pacific staghorn sculpin (*Leptocottus armatus*), and round stingray (*Urobatis halleri*); one non-native species was identified, the western mosquitofish (*Gambusia affinis*). The most common fish caught using the beach seine method was topsmelt, with 593 individuals across all sites. Killifish and arrow gobies were the next most abundant species, with 516 and

382, respectively. Macroinvertebrates caught in the surveys were also identified. The most common invertebrate captured in the seines was the California horn snail (*Cerithidea californica*).

A total of five species of fish were found in the shrimp trawl surveys in Ballona Creek: giant kelpfish (*Heterostichus rostratus*), California halibut, (*Paralichthys californicus*), California lizardfish, (*Synodus lucioceps*), diamond turbot (*Hypsopsetta guttulata*), and kelp bass (*Paralabrax clathratus*). Three species not identified in the first baseline year (i.e. California lizardfish, kelp bass, and giant kelpfish) were captured in the second baseline year shrimp trawls.

Herpetofauna

Surveys throughout the BWER recorded ten species of herpetofauna during the second baseline year. Several surveys for endangered and special concern herpetofauna species in the last 25 years have found only one endangered species, the California legless lizard (*Anniella pulchra*). The California legless lizard, a California Species of Special Concern, was confirmed on site in the dune habitats of Area B in the first Baseline year (Johnston et al. 2011). In order to minimize habitat disturbance, legless lizard survey protocols were not repeated in the second year, however continued presence was confirmed in Area B dune habitats during coverboard surveys.

Surveys for the second baseline year were altered to assess a wider diversity of herpetofauna species and to address potential data gaps. Cover board surveys were implemented in an effort to capture both snakes and lizards with less effort than the first baseline year. Cover board surveys consisted of 190 sheets of plywood placed in arrays over rodent burrows. A combination of cover board surveys and site searches resulted in the confirmed presence of ten herpetofauna species including: Great Basin fence lizard (*Sceloporus occidentalis*), western side-blotched lizard (*Uta stansburiana*), San Diego alligator lizard (*Elgaria multicarinata*), California kingsnake (*Lampropeltis getulus*), San Diego gopher snake (*Pituophis melanoleucus*), Southern Pacific rattlesnake (*Crotalus viridis*), Baja California treefrog (*Pseudacris regilla*), California legless lizard (*Aniella pulchra pulchra*), San Bernardino ring-necked snake (*Diadophis punctatus modestus*), and garden slender salamander (*Batrachoseps major*). Two species (i.e. San Bernardino ring-necked snake and garden slender salamander) not identified in the first baseline year were confirmed using the cover board array method in the second baseline year.

Mammals

Mammals are an important link in functioning wetland and upland ecosystems. In the 2011 baseline surveys, mammal surveys were conducted using targeted Sherman live traps for small mammals, road mortality surveys, and baited camera stations (Critter Cams) for medium and large mammals.

Targeted Sherman live trap surveys were conducted fall 2011 in salt marsh habitats, primarily to confirm presence of the South Coast marsh vole (*Microtus californicus stephensi*), a California Species of Special

Concern. Forty-eight western harvest mice (*Reithrodontomys megalotis)* were captured during the surveys with an overall capture rate of 13.3%. The South Coast marsh vole was not captured during the live trapping surveys, yet visual observations identified a vole species (*Microtus Californica*) as present. The species is believed to be the South Coast marsh vole due to habitat and historic records but cannot be confirmed without skull measurements.

Eight native species were live captured using Sherman traps, observed visually, or observed using Critter Cams during the first baseline year: California ground squirrel (*Spermophilus beecheyi*), coyote (*Canis latrans*), desert cottontail (*Sylvilagus audubonii*), pocket gopher (*Thomomys bottae*), raccoon (*Procyon lotor psora*), striped skunk (*Mephitis mephitis*), western harvest mouse (*Reithrodontomys megalotis*), and California meadow vole (*Microtus californicus*). Five non-native species were observed or captured: Virginia opossum (*Didelphis virginiana*), Eastern fox squirrel (*Sciurus niger*), domestic dog (*Canis familiaris*), domestic cat (*Felis cattus*), and rat (*Rattus sp*).

Semi-monthly vertebrate mortality surveys were initiated in the second baseline year to identify the locations, time of year, and species most affected by the thoroughfares bisecting the BWER. The highest mortality rates were in July (4.7 kills/ mile) and the lowest in March (1.5 kills/ mile). The most commonly identified vertebrate mortality species over the course of the second baseline year were cottontail rabbits, squirrels, and opossums.

Avifauna

While birds are one of the most commonly observed groups of animals at the BWER, they are seldom surveyed comprehensively. Reserve-wide semi-annual surveys were performed in October 2010 and April 2011. Digitized spot-maps display the spatial and temporal distribution of birds on the reserve, as well as their observed relative abundances. Waterbird surveys were conducted on a semi-monthly basis. Protocol surveys were performed for two special-status species: the Light-footed Clapper Rail (*Rallus longirostrus levipes*) and the California Gnatcatcher (*Polioptila californica*).

A total of 135 species and distinctive subspecies were recorded during the second year of baseline assessment (combining all survey types). Bird species richness was similar between both the first and second baseline year reserve-wide surveys (68 species in October 2010 vs. 64 species in October 2009; 69 species in April 2011 vs. 72 species in April 2010). Sixty-seven species were recorded along the Ballona Creek channel during five, one-day waterbird surveys. February 2011 had the highest numbers of individual birds (2,009 individuals of all species combined) and June 2011 had the lowest usage of Ballona Creek (188 individuals).

A total of 26 special-status species were detected during the second baseline year. This total includes vagrant species that use the site very briefly, or in small numbers, presumably en route to breeding or wintering grounds elsewhere. A total of seven special status species were detected on site exhibiting the behavior for which a special status listing is afforded (e.g. nesting): Belding's savannah sparrow

(*Passerculus sandwichensis*), California gnatcatcher (*Polioptila californica*), Cooper's hawk (*Accipiter cooperii*), Double-crested Cormorant (*Phalacrocorax auritus*), Merlin (*Falco columbarius*), Vesper Sparrow (*Pooecetes gramineus*), and Western Meadowlark (*Sturnella neglecta*).

INVERTEBRATES

The benthic infaunal and epifaunal aquatic invertebrate communities provide essential ecosystem services and support. The presence or absence of certain infaunal taxa within tidal channels and mudflats can indicate water quality, identify anthropogenic stressors to the estuary, and gauge the potential to support other trophic levels. For the second year of the BAP, infaunal benthic invertebrate sampling was conducted semi-annually (October 2010 and April 2011) in seven locations: two in Area A and five in Area B. Sampling, processing, and preservation methods followed those outlined in the first baseline year for October. The October samples were sorted and analyzed using preliminary processing methods only and are therefore not included in the species-level results.

The April 2011 samples were sorted and identified to the lowest practicable taxon by benthic invertebrate taxonomists at Dancing Coyote Environmental (DCE, Inc.). A total of 9,064 individuals representing forty-two taxa were identified in small and large cores in April of the second baseline assessment year. *Monocorophium insidiosum*, *Grandidierella japonica*, *Capitella capitata* Cmplx, *Acteocina inculta*, Oligochaeta, and *Streblospio benedicti* were the most common species found in order of greatest to lowest density of individuals / m^2.

Epifaunal invertebrate surveys followed the methods utilized in the first baseline year with the addition of Transect 4 and increased frequency from semi-annually to quarterly (January, March, June, and September 2011). Epifaunal benthic invertebrate surveys consisted of *in situ* counts of the California horn snail (*Cerithidea californica*). *C. californica* abundances were found to be highest in March 2011 (422.8 individuals / m^2) and lowest in September 2011 (239.0 individuals / m^2).

Flying aerial arthropod biomass surveys were conducted following the methods from the first baseline year. The objective was to extrapolate arthropod biomass by weight ($mg/m^2/day$) for each habitat using sticky traps. Results of flying invertebrate data indicate the lowest productivity in the salt pan habitat and fairly uniform productivity in the brackish marsh, low salt marsh, mid salt marsh, high salt marsh, and upland scrub habitats. The seasonal wetland had the highest average total aerial arthropod productivity and the highest level of variability between transects. Three special status butterfly species were observed at the BWER during the second baseline year. The Monarch butterfly, *Danaus plexippus,* and the Wandering skipper, *Panoquina errans,* were observed during site-wide surveys. The Federally Endangered El Segundo blue butterfly, *Euphilotes battoides allyni,* was observed on 19 July 2011 (D. Cooper, Cooper Ecological, pers. comm. 2011). Species-level terrestrial surveys will be conducted in the third Baseline year utilizing pitfall traps.

Table 1. Calendar of completed survey events by month for the second year of baseline assessments at the BWER.

	TARGET	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	FREQUENCY
CHEMICAL	Water Quality - Metals					X									semi-annually
CHEMICAL	Water Quality - Bacteria							X	X						dry and wet season
CHEMICAL	Water Quality - Nutrients							X	X						dry and wet season
CHEMICAL	Water Quality - perm. data sonde	<-X->	<-X->	<-X->	<-X->	<-X->	<-X->	<-X->	<-X->	<-X->	<-X->	<-X->	<-X->	<-X->	throughout year
CHEMICAL	Sediment - Metals							X							semi-annually
CHEMICAL	Soils - Metals & grain size	<-X->	<-X												once every 2-5 years
BIOLOGICAL	Vegetation - submerged/algae	X			X			X			X			X	quarterly
BIOLOGICAL	Vegetation - upland habitats								X->	<-X->	<-X				annually (spring)
BIOLOGICAL	Vegetation - marsh habitats												X->	<-X	annually (summer)
BIOLOGICAL	Seed bank study					X->	<-X->	<-X->	<-X->	<-X					annually
BIOLOGICAL	Birds - volunteer surveys	X	X	X											monthly
BIOLOGICAL	Birds - professional surveys					X			X						wintering & nesting surveys
BIOLOGICAL	Small Mammals												X->	<-X	targeted surveys
BIOLOGICAL	Large Mammal	<-X->	<-X->	<-X				X->	<-X->	<-X->	<-X->	<-X->	<-X->	<-X	throughout year
BIOLOGICAL	Herpetofauna (coverboards)						<-X->	<-X->	<-X->	<-X->	<-X				late winter through spring
BIOLOGICAL	Fish - channels and ditch	X							X			X			semi-annually (fall & spring)
BIOLOGICAL	Fish - Ballona Creek	X										X		X	semi-annually (fall & spring)
BIOLOGICAL	Invert - flying	<-X->	<-X							X->	<-X->	<-X->	<-X->	<-X	annually (spring/summer)
BIOLOGICAL	Invert - terrestrial	<-X->	<-X							X->	<-X->	<-X->	<-X->	<-X	annually (spring/summer)
BIOLOGICAL	Invert, infauna - benthic		X						X						semi-annually
PHYSICAL	Innundation											X	X	X	semi-annually
PHYSICAL	Elevations		X->	<-X		X->	<-X								every 5 years
PHYSICAL	Channel Cross-Sections									X	X	X			biannually
PHYSICAL	Roadkill surveys	X	X	X	X	X	X	X	X	X	X	X	X	X	semi-monthly

Photo credit: E.Tuttle

INTRODUCTION

Ballona Wetlands Ecological Reserve, Los Angeles, California
Santa Monica Bay Restoration Commission

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INTRODUCTION

"Mankind's failure to use ecological principles to minimize negative impacts of human activities is arguably the most important failure of the twentieth century" (Karr 1987).

The Santa Monica Bay Restoration Commission (SMBRC) is a collaboration of federal, state and local entities whose mission is to restore and enhance the Santa Monica Bay (Bay). Through actions and partnerships, the SMBRC protects and improves the health of the 266-square mile Bay and its 400-square mile watershed, located in the second most populous region in the United States.

The SMBRC is a National Estuary Program (NEP) of the United States Environmental Protection Agency (USEPA). The NEP was established by Congress in 1987 to improve the quality of estuaries of national importance, with a focus on habitat restoration and protection as well as water quality. Stakeholders of the SMBRC developed the Bay Restoration Plan (BRP), which includes 14 goals and 67 objectives, for protecting and restoring the Bay. Scientific monitoring of the Bay's natural resources and restoration of impaired Bay habitats are important goals of the BRP.

In 2009, the SMBRC partnered with the California Department of Fish and Game (CDFG) and the California State Coastal Conservancy (SCC) to assess the ecological condition of the Ballona Wetlands Ecological Reserve (BWER). The Baseline Assessment Program (BAP) was developed to comprehensively survey the biological, chemical, and physical characteristics needed to inform the State's restoration planning process at the BWER, as well as to develop baseline information and data to assist long-term and regional monitoring programs.

The second annual BAP report is a supplement to the comprehensive first year report. It presents data collected during the second year of the BAP and compares results across both years when possible.

Overview and Site History

The Ballona Wetlands is one of approximately 40 coastal wetlands along the 1,045 miles of the Southern California coast between Point Conception and Mexico. The original Ballona Wetlands ecosystem was approximately 2000 acres and included a variety of habitats, dominated by over 1,200 acres of vegetated wetland in 1876 (Grossinger et al. 2010). Since then, the site has been impacted by agriculture, roads, railways, a marina, industry, housing, and the channelization of Ballona Creek. The remaining 600-acre parcel was purchased by the State in 2004 and designated an Ecological Reserve. Wetlands at the site have been reduced to approximately 67 acres of muted intertidal salt marsh and mudflat, with the remaining area largely converted to seasonal wetland or upland habitats. The BWER is now the largest opportunity to restore critical coastal wetlands in the Santa Monica Bay and Los Angeles County.

The Freshwater Marsh is a 24-acre freshwater treatment wetland bordering the BWER, which treats stormwater from neighboring roads and communities. The Freshwater Marsh is monitored (Read and Strecker 2009, Read and Strecker 2010) and maintained separately from the rest of the BWER and is not included in the BAP.

Goals of the Baseline Assessment Program

Previous scientific surveys of the BWER focused largely on individual aspects of the ecosystem or on limited areas. The BAP provides a comprehensive baseline biological assessment designed to determine the biotic integrity of the ecosystem. Biotic integrity can be defined as "the capability of supporting and maintaining a balanced, integrative, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of natural habitat of the region" (Karr and Dudley 1981).

The BAP is a two-year program. This report presents the results of the second year of the baseline data collection. It includes protocol development with scientific review, coordination with regional restoration programs, implementation of the assessment protocols, data analysis and reporting, and external scientific review. The goals of the BAP include:

(1) Provide a measure of pre-restoration baseline conditions at the BWER;
(2) Compare the results from year one and year two;
(3) Increase comprehensive knowledge of the health and functioning of the site in an urban environment;
(4) Assess ecological processes, cross-habitat comparisons, and species interactions;
(5) Fill data gaps at the Ballona Wetlands and develop protocols for addressing data gaps at other wetland projects;
(6) Inform adaptive management and long-term restoration plans;
(7) Develop a framework for scientific, regional wetland monitoring protocols for southern California;
(8) Inform both a site-specific and regional long-term monitoring program;
(9) Establish an informed, scientifically valid basis for improved watershed management to protect, prevent and reduce pollution to the BWER;
(10) Contribute chemical and ecological data from the BWER to local, regional, and national databases.

For a detailed description of the protocol development of the Baseline Assessment Program, refer to the Introduction Chapter of the first year Baseline Report (Johnston et al. 2011).

Scientific Review

Several stages of the BAP underwent external scientific review (Figure i.1). The SMBRC received input from the WRP Science Advisory Panel, SMBRC Technical Advisory Committee, and many research scientists conducting similar studies at other wetlands in southern California. Through this process, the SMBRC proposed protocols for feedback and worked with researchers on detailed protocols. Development of the protocols was an iterative process to achieve the desired goals while working within the unique constraints and conditions of the BWER. Protocols have been adapted in the field when necessary, with direct consultation from experts and after the implementation of the first baseline year. Additionally, individual chapters of the baseline report underwent external expert review (see list of reviewers).

Report Structure

This report is divided into twelve chapters, one for each of the 11 monitoring components (i.e. water quality, marine sediments, terrestrial soils, vegetation, ichthyofauna, herpetofauna, mammals, avifauna, benthic invertebrates, terrestrial invertebrates, and physical characteristics), and one for the introduction. Each chapter includes the goals of the assessment program for that component of the study, revisions or new methods used in the second year BAP surveys, results, and preliminary analyses of the results from both baseline years. Each chapter also includes an outline of sampling planned for the third monitoring year as the transition is made to long-term monitoring.

Detailed methods are provided in the Baseline Assessment Program: 2009-2010 Report, including locations and parameters targeted. This Report is available for free download (www.ballonarestoration.org). Results are summarized within the text and detailed data are available in the appendices. Interpretations and inferences of the potential relationships of these data will be provided in future publications through in-depth analyses.

SITE DESCRIPTION

The site description for the BWER is modified from the Draft Existing Conditions Report compiled by Phillip Williams and Associates (PWA) in 2006. For additional descriptive details, reference PWA 2006. In previous studies, the BWER has been divided into three areas designated as Areas A, B, and C (Figure i.2). This nomenclature will be continued throughout this report to facilitate comparison to previous reports.

Area A is the approximately 139 acre portion of the BWER that lies north of Ballona Creek, west of Lincoln Boulevard, and south of Fiji Way (Figure i.2). Fill was placed on Area A during the excavations of Ballona Creek and Marina del Rey which resulted in elevations ranging between approximately nine and 17 feet above mean sea level (MSL). Development of Area A is limited to a parking area along the western boundary, a drainage channel (Fiji Ditch) along the northern boundary, and four monitoring well sites maintained by the Gas Company in the western end.

Area B is the approximately 338 acre portion of the BWER that lies south of Ballona Creek and west of Lincoln Boulevard (Figure i.3). Area B extends south to Cabora Drive and contains a utility access road near the base of the Playa Del Rey bluffs. To the west, Area B extends through the dunes to Playa Del Rey. Area B elevations generally range from approximately two to five feet MSL, extending up to 50 feet MSL at the Del Rey bluffs. Culver Boulevard and Jefferson Boulevard are major traffic thoroughfares that traverse Area B. Additionally, the Gas Company maintains an access road that connects its facility in southern Area B to Jefferson Boulevard. Area B contains the largest area of remnant unfilled wetlands with abandoned agricultural lands to the southwest, and the Freshwater Marsh to the northeast. The Gas Company maintains one active oil well in Area B.

Area C is the approximately 66 acre portion of the BWER that is located north of Ballona Creek and east of Lincoln Boulevard (Figure i.1). The 90 Freeway forms the northeastern border of Area C, and Culver Boulevard bisects Area C in an east-west direction. Area C contains fill from the construction of the Ballona Creek flood channel, developments such as Marina del Rey, and the 90 Freeway. Elevations range from approximately 4.5 feet to 25 feet MSL. Area C contains Little League baseball fields.

All three Areas are surrounded by dense urban development.

Figure i.1. Aerial of the BWER and Marina del Rey (photo: SMBRC 2007). Note: the Freshwater Marsh is not included in the BAP surveys.

Personnel Summary Information

Monitoring was conducted by expert regional scientists, staff scientists, volunteer experts, additional in-house staff, contracted employees, and, when appropriate, student interns and volunteers.

Over 750 staff and expert scientist field hours were logged over the course of 150 field days in the second baseline year, not including laboratory and data analyses. Professional participants included: Karina Johnston, Sean Bergquist, Dan Cooper, Dr. Shelley Luce, Dr. John Dorsey, Dr. Sean Anderson, Dr. José Saez, Dr. Guangyu Wang, Jack Goldfarb, Andrew Keller, Ivan Medel, Elena Del Giudice-Tuttle, and Charlie Piechowski. Additional scientific reviewers and technical advisory committees participated in the development and review of the program and reporting materials (see document cover pages). 2,356 internship and volunteer hours were completed during the second baseline year.

For more information and electronic copies of the full report, visit www.ballonarestoration.org.

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Photo credit: K. Johnston

CHAPTER 1:
WATER QUALITY

Ballona Wetlands Ecological Reserve, Los Angeles, California
Santa Monica Bay Restoration Commission

Prepared for: California State Coastal Conservancy
June 2012

Authors: Karina Johnston and John Dorsey

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WATER QUALITY

INTRODUCTION

Water quality measurements may be indicators of both human health concerns and overall chemical and physical conditions of a site. Water quality may be negatively affected by upstream inputs to the system (Nichols 1983), or by poor circulation, lack of tidal flushing, or increased sediment transport in wetlands (Zedler 2001). Evaluating water quality in the Ballona Wetlands Ecological Reserve (BWER) by monitoring constituents of concern is vital to understanding the system as a whole. Constituents of concern are defined as chemicals or pollutants identified for evaluation as potential stressors.

The principal goal of the BWER water quality studies was to build on existing research, track water quality parameters over time, and identify areas of concern (if applicable). Specific goals of the second baseline assessment year included:

1) Maintain a permanent data sonde for continuous monitoring of general water quality parameters in the east tide channel of Area B;
2) Determine fecal indicator bacteria (FIB) and nutrient fluctuations across tidal cycles within the tide channels, Fiji Ditch, and Ballona Creek;
3) Determine constituents of concern in the water within the tide channels of Area B, the Fiji Ditch in Area A, and the estuary portion of Ballona Creek.

All values for acute and chronic toxicity are from the National Recommended Water Quality Criteria compiled by the United States Environmental Protection Agency (USEPA) pursuant to Section 304(a) of the Clean Water Act (CWA), henceforth referred to as USEPA 2009.

METHODS

Seven permanent water quality sampling stations were assessed during the second baseline year. Stations were identical to those assessed in the first baseline year (Chapter 1: Water Quality, Baseline Assessment Report: 2009-2010, Johnston et al. 2011). Depending on the sampling parameters, all stations or a subset of the stations were monitored for various water quality parameters, as well as sediment and biota, during the second baseline year (Table 1.1).

Table 1.1. Sampling locations for water quality studies and overlapping sediment and biological studies within the BWER during the second baseline year.

	# of surveys	Fiji Ditch		Ballona Creek	Area B – Lower Marsh				
		BW1	**BW2**	**BW3**	**BW4**	**BW5**	**BW6**	**BW7**	**BW8**
Data sonde	Continuous				X				
Stratification studies	2				X				
Dissolved metals	1	X		X	X	X	X	X	X
Fish	3	X	X		X	X		X	
Sediment	1				X	X	X	X	X
Benthic Invertebrates	2	X	X		X	X	X	X	X

Data Sonde Methods

One permanent data logger (YSI 6600 EDS V2) was installed in the main tidal channel across from the tide gate to collect data continuously throughout the year. Data sonde methods, calibration, cleaning, quality assurance and quality control (QAQC), and assessment followed protocols developed and described in the first baseline report (Chapter 1: Water Quality, Johnston et al. 2011).

The data collected during June, July, and August did not meet the quality control requirements by failing to calibrate and are not included in the analyses. The malfunctioning probe was replaced for subsequent months.

Stratification Sampling Methods

Stratification studies were conducted in March and April of the second baseline year (in addition to those completed during July and August of the first baseline year), to investigate the tidally-influenced movement of bacteria in the wetlands and the relationship to turbidity and sediment resuspension. Stratification studies were conducted on 18 March and 15 April 2011 to determine the stratification of specific water quality parameters within the water column during varying tidal levels, including: temperature (C°), salinity (ppt), pH, dissolved oxygen (mg/L), turbidity (NTU), nutrients (NO_3^-, NO_2^-, PO_4^{-3}) and fecal indicator bacteria (FIB: total coliforms, *Escherichia coli*, enterococci, MPN / 100mL). The study was conducted at Station BW4 near the east tide gate in the BWER where water was sampled at fixed points above the sediment four times during a tidal cycle (Figure 1.1). During each sampling period a reference surface sample was collected at station BW4 and in the estuary approximately 50 m upstream from the tide gate. Collection methods and laboratory processing methods followed protocols developed and described in the first baseline report (Chapter 1: Water Quality, Johnston et al. 2011).

FIB data were evaluated using the Ballona Creek Bacteria Total Maximum Daily Load (TMDL) numeric targets, prepared by the State Water Resources Control Board (SWRCB 2006; Table 1.2).

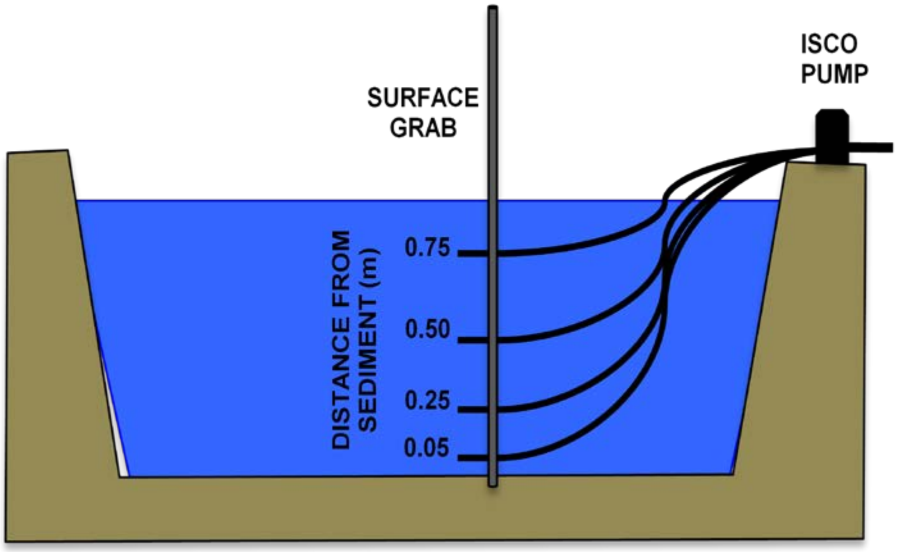

Figure 1.1. Configuration of sampling array for the stratification studies (courtesy: J. Dorsey 2012).

Table 1.2. Numeric targets for the Ballona Creek bacteria TMDL (modified from SWRCB 2006). Note: asterisk indicates that total coliform density shall not exceed 1,000 / 100 mL, if the ratio of fecal-to-total coliform exceeds 0.1.

Single sample		***Geometric mean***	
Bacteria type	**MPN / 100 mL**	**Bacteria type**	**MPN / 100 mL**
Fecal coliform	400	Fecal coliform	200
Enterococci	104	Enterococci	35
Total coliform*	10,000	Total coliform*	1,000

Dissolved Metal Sampling Methods

Dissolved metals were sampled once in the second baseline year on 26 January 2011 to capture one-time wet season values at the same seven stations listed above. Sampling stations, collection methods, and laboratory processing methods followed protocols developed and described in the first baseline report (Chapter 1: Water Quality, Johnston et al. 2011). Data were evaluated using the US Ambient Water Quality Criteria[1] of the USEPA for acute and chronic marine toxicity, and TMDL limits (Table 1.3; USEPA 2009).

Table 1.3. Metal constituents of concern and limits (ppb).

	EPA WATER QUALITY CRITERIA[1]		TMDL LIMITS[2]	
	Marine		*for Ballona Creek*	
	acute	**Chronic**	**dry**	**wet**
Phosphorus	----	----	----	----
Potassium	----	----	----	----
Iron	300	50	----	----
Manganese	----	100	----	----
Zinc	90	81	300	94
Copper	4.8	3.1	23	11
Boron	----	1200	----	----
Calcium	----	----	----	----
Magnesium	----	----	----	----
Sodium	----	----	----	----
Sulfur	----	----	----	----
Molybdenum	----	23	----	----
Aluminum	----	----	----	----
Arsenic	69.0	36	----	----
Barium	1000	200	----	----
Cadmium	40	8.8	----	----
Chromium (III)	----	----	----	----
Chromium (IV)	----	----	----	----
Cobalt	----	1.0	----	----
Lead	210	8.1	8.1	49
Lithium	----	----	----	----
Mercury	1.8	0.94	----	----
Nickel	74	8.2	----	----
Selenium	290	71	----	----
Silicon	----	----	----	----
Silver	0.95	----	----	----
Strontium	----	----	----	----
Tin	0.42	0.0074	----	----
Titanium	----	----	----	----
Vanadium	----	50	----	----

[1] USEPA (2009). National Recommended Water Quality Criteria.

[2] SWRCB (2006). Total Maximum Daily Load for Metals in Ballona Creek.

RESULTS

Appendix A.1 contains the general sampling parameters for each survey recorded by the handheld YSI probe, including: temperature, salinity, dissolved oxygen, and pH. A summary of each water quality survey from the second Baseline year is included in this report.

Overall, water quality sampling showed high levels of FIB, and indicated that the tidal portion of the BWER generally functions as a sink, rather than a source of bacteria, with higher bacteria numbers in the Ballona Creek estuary than in the tide channels. During stronger ebb flows, the wetlands did contribute

FIB to the adjacent estuary as sediments were suspended along with associated FIB. However, concentrations in the ebb flows from the BWER typically were lower than those measured in the estuary during simultaneous sampling.

Appendix A.2 displays the raw data results (ppb) for each dissolved metal constituent analyzed in January. Dissolved metals exceeding acute toxicity levels (USEPA 2009) at multiple stations included: zinc, copper (all stations), cadmium, selenium, and tin. Additionally, dissolved metals exceeding chronic toxicity levels (USEPA 2009) at multiple stations included: iron, boron (all stations), cadmium, cobalt, and lead.

Precipitation influences wet weather sampling and surveys, and flushes toxins and constituents of concern into the stormdrain system. During October and December of the second Baseline year the Los Angeles International Airport rain gauge recorded higher than average rainfall (Figure 1.2). Total precipitation from September 2010 to September 2011 was 34.16 cm. The average total from September to September (1944-2011) is 31.04 cm. According to NOAA, the December precipitation total was higher in 2010 than in any previously recorded year (NOAA, accessed May 2012).

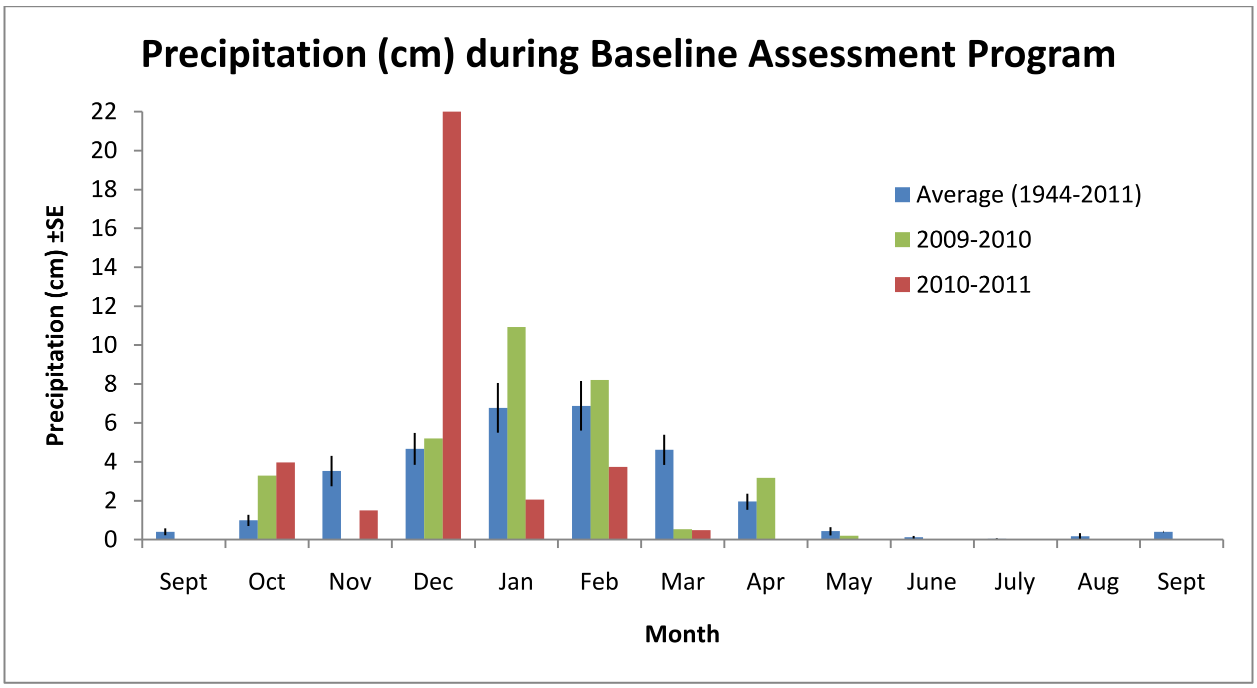

Figure 1.2. Precipitation during the Baseline Assessment Program (September 2009 through September 2011) from the Los Angeles International Airport rain gauge (http://www.cnrfc.noaa.gov, accessed May 2012).

Data Sonde Results

The data obtained using the permanently stationed sonde included readings every 15 minutes over the course of the entire baseline year, before Quality Assurance and Quality Control (QAQC) measures were implemented. Data obtained were included in separate analyses or as part of other water quality surveys (below and Appendix A.1).

Stratification Results

Stratification studies were conducted to investigate the tidally-influenced movement of bacteria in the wetlands and the relationship to turbidity and sediment resuspension. Average turbidity and FIB concentrations are presented in Tables 1.4 and 1.5. Turbidity was consistently higher on the low ebb tide due to resuspension of sediment on the outflow tide. FIB were stratified within the water column, with higher FIB counts at the surface and at the lowest depths. Detailed analyses and data from the four stratification studies will be presented in a publication currently in development (Johnston et al., *in prep*).

All total coliform FIB average values exceeded the numeric target TMDL's for geometric mean (1,000 MPN/100mL), but those on the early incoming tides for both months were below the single sample total coliform limit (10,000 MPN/100mL) (Tables 1.4 and 1.5). All average values for *E. coli* were below both the geometric mean and single sample TMDL numeric targets for fecal coliform bacteria. Average enterococci numbers exceeded the geometric mean TMDL numeric target (35 MPN/100mL) for all sampling times during March, but only the first sampling time (incoming tide) in April.

Table 1.4. March FIB (MPN/100mL) and turbidity (NTU) averages across all strata and Ballona Creek (BC).

TIDE (m)	TOTALS	BC TOTALS	*E. COLI*	BC *E. COLI*	ENTEROCOCCI	BC ENTEROCOCCI	TURBIDITY	BC TURBIDITY
0.9	8520.9	24192.0	81.1	194.7	136.2	354.3	2.1	2.6
1.4	6648.3	12210.3	50.7	97.3	1512.5	166.7	2.3	1.9
0.2	20916.8	24192.0	37.8	313.7	149.3	185.3	4.9	1.9
-0.3	24192.0	15665.3	15.2	97.7	72.5	17.3	32.2	5.2

Table 1.5. April FIB (MPN/100mL) and turbidity (NTU) averages across all strata and Ballona Creek (BC).

TIDE (m)	TOTALS	BC TOTALS	*E. COLI*	BC *E. COLI*	ENTEROCOCCI	BC ENTEROCOCCI	TURBIDITY	BC TURBIDITY
1.0	6502.9	17574.3	50.9	86.0	135.1	477.7	3.8	2.4
1.2	6029.3	10734.0	23.3	38.0	21.8	59.3	3.2	1.5
0.7	8766.2	10462.0	24.6	37.7	16.7	30.7	3.8	1.1
0.0	23470.5	6709.7	11.7	63.0	13.3	13.3	22.5	1.6

Average nitrite and nitrate values were low; none of the average nitrate or nitrite values approached 0.1 ppm (Tables 1.6 and 1.7). All of the average phosphate values exceeded 0.1 ppm. The highest phosphate levels were during the ebb tide (1500) of the March study (Table 1.6).

Table 1.6. Nutrient results from the March stratification study.

TIME	TIDE (m)	NITRATES (NO3)	NITRITES (NO2)	PHOSPHATES (PO4)
0600	0.9	0.01	0.0088	0.33
0900	1.4	0.01	0.0078	0.19
1200	0.2	0.01	0.0105	0.31
1500	-0.3	0.00	0.0195	1.10
CREEK	----	0.03	0.0200	0.21

Table 1.7. Nutrient results from the April stratification study.

TIME	TIDE (m)	NITRATES (NO3)	NITRITES (NO2)	PHOSPHATES (PO4)
0500	1.0	0.02	0.0150	0.28
0800	1.2	0.02	0.0112	0.61
1100	0.7	0.02	0.0108	0.37
1400	0.0	0.00	0.0140	0.57
CREEK	----	0.06	0.0310	0.28

ANALYSIS OF BASELINE RESULTS

A primary goal of the water quality Baseline surveys at the BWER was to track constituent input to the estuary system and to identify areas or constituents of concern. Several areas for evaluation within the BWER were identified based on water input to the estuarine system. The Fiji Ditch in Area A is the tidal area that receives water through a culvert connected to Basin H in Marina del Rey. The tidal channels of Area B receive water from the Ballona Creek estuary; during the wet season, they also receive freshwater runoff from the surrounding environs. Ballona Creek receives dry and wet season freshwater from the surrounding watershed through the stormdrain system. The estuarine portion of Ballona Creek within the BWER is also fully tidal with salt water input from Santa Monica Bay.

Overall, the BWER experienced highly variable concentrations (MPN/100mL) of FIB ranging within three orders of magnitude. There was contaminated FIB input both from Marina del Rey (to the Fiji Ditch) and from Ballona Creek (to the tidal channels). FIB concentrations in the Ballona Creek estuary during the baseline years fairly consistently exceeded TMDL numeric targets (especially for total coliform FIB), sometimes by two orders of magnitude. The City of Los Angeles' TMDL monitoring and implementation plans are available for download from the Bureau of Sanitation website (http://www.lacitysan.org/).

Baseline data from both years and past publications (Dorsey 2006, Dorsey et al. 2010) suggest that the wetlands are acting as a sink for FIB. Even during periods of ebb flow spikes in FIB concentration due to resuspension, the values were consistently lower than those in the Ballona Creek estuary, suggesting a dilution effect.

Nutrient concentrations from both baseline years and additional eutrophication studies (McLaughlin et al., *in prep*) indicate that the BWER does not currently experience substantial eutrophication, or excess nutrient inputs to the system, though there are periods of lower dissolved oxygen associated with muted tidal conditions and tidal fluctuations.

Several metals consistently exceeded various toxicity recommended levels (USEPA 2009) and TMDL numeric targets, including copper, cadmium, zinc, lead, and selenium (for the full list, see Results section in the first and second year baseline reports). The water quality samples were collected as single surface grab samples and are only representative of that location at one point in time. The Southern California Coastal Water Research Project (SCCWRP) has conducted several studies on constituents and contaminants in the Ballona Creek estuary under both dry and wet weather conditions across a larger temporal scale (Brown et al. 2011, Stein and Tiefenthaler 2004, 2005; Stein and Ackerman 2007). These and additional reports are available for download on their website (www.sccwrp.org) and provide supplemental information regarding water quality in Ballona Creek.

FUTURE DIRECTIONS

The permanent data sonde continues to be maintained and calibrated monthly. Nutrient and bacteria samples will be surveyed opportunistically, or if additional funding is procured.

APPENDIX A.1

Water quality conditions for all sampling events

Stratification Studies						
Date	**Time**	**Pole Depth (m)**	**Temp (ºC)**	**Salinity (ppt)**	**DO (mg/L)**	**pH**
3/18/2011	600	0.05	14.77	32.60	7.75	8.07
3/18/2011	600	0.25	14.80	32.42	8.09	8.08
3/18/2011	600	0.5	14.96	29.47	8.76	8.16
3/18/2011	600	0.75	14.84	29.32	8.75	8.15
3/18/2011	600	surface	14.75	29.31	8.86	8.07
3/18/2011	600	creek	14.57	25.85	9.12	8.30
3/18/2011	900	0.05	14.11	34.30	8.60	8.08
3/18/2011	900	0.25	14.10	34.12	8.66	8.08
3/18/2011	900	0.5	14.10	34.04	8.68	8.08
3/18/2011	900	0.75	14.25	31.68	8.79	8.10
3/18/2011	900	surface	13.02	23.50	9.25	8.25
3/18/2011	900	creek	14.19	31.30	9.15	8.17
3/18/2011	1200	0.05	17.20	26.99	10.75	8.15
3/18/2011	1200	0.25	17.09	26.93	10.74	8.14
3/18/2011	1200	0.5	17.05	26.89	10.74	8.14
3/18/2011	1200	surface	17.02	27.16	10.7	8.14
3/18/2011	1200	creek	16.94	14.75	8.64	8.24
3/18/2011	1500	0.05	25.09	4.10	8.70	8.08
3/18/2011	1500	surface	25.11	0.01	8.60	8.07
3/18/2011	1500	creek	17.81	18.53	9.47	8.20
4/15/2011	500	0.05	15.44	31.68	6.65	7.96
4/15/2011	500	0.25	15.60	31.05	6.94	8.00
4/15/2011	500	0.5	15.75	30.41	7.23	8.03
4/15/2011	500	0.75	15.75	30.26	7.28	8.03
4/15/2011	500	surface	15.76	28.77	7.39	8.02
4/15/2011	500	creek	15.95	26.90	6.97	8.10
4/15/2011	800	0.05	13.76	34.08	6.17	7.86
4/15/2011	800	0.25	13.75	34.08	6.13	7.86
4/15/2011	800	0.5	13.76	34.06	6.20	7.86
4/15/2011	800	D	14.14	33.09	6.31	7.89
4/15/2011	800	surface	15.00	27.70	7.40	8.09
4/15/2011	800	creek	15.15	28.85	7.39	8.12
4/15/2011	1100	0.05	16.49	31.40	8.34	7.99
4/15/2011	1100	0.25	16.74	30.64	8.92	8.03
4/15/2011	1100	0.5	16.85	30.30	9.06	8.05
4/15/2011	1100	0.75	16.80	30.97	9.06	8.06

Stratification Studies						
Date	**Time**	**Pole Depth (m)**	**Temp (ºC)**	**Salinity (ppt)**	**DO (mg/L)**	**pH**
4/15/2011	1100	surface	16.80	30.97	9.06	8.06
4/15/2011	1100	creek	17.62	27.15	8.03	8.08
4/15/2011	1400	0.05	28.03	25.20	15.81	8.36
4/15/2011	1400	surface	28.03	25.20	15.81	8.36
4/15/2011	1400	creek	19.85	17.41	10.52	8.06

Ichthyofauna Sampling						
Date	**Time**	**Location**	**Temp (ºC)**	**Salinity (ppt)**	**DO (mg/L)**	**pH**
9/22/2010	1930	DITCH A**	18.94	34.20	7.36	----
9/22/2010	1802	DITCH B**	18.91	34.18	7.71	----
9/22/2010	1955	DITCH C**	18.99	34.16	6.94	----
9/23/2010	2006	WETLAND A	19.49	14.25	9.86	8.21
9/23/2010	2046	WETLAND B	19.04	15.25	8.76	8.27
9/23/2010	2149	WETLAND C	17.75	28.15	7.94	8.34
9/27/2010	0850	DITCH A**	16.49	31.80	5.05	7.32
9/27/2010	----	DITCH B	**Inaccessible**			
9/27/2010	1005	DITCH C**	15.85	32.38	5.95	7.35
9/28/2010	0911	WETLAND A	20.26	26.82	6.49	7.70
9/28/2010	1045	WETLAND B	20.79	29.25	7.54	7.70
9/28/2010	1130	WETLAND C	21.07	25.95	7.49	7.38
4/17/2011	0856	DITCH A*	14.50	32.10	----	----
4/17/2011	0952	DITCH C*	14.43	32.09	----	----
4/17/2011	1730	DITCH A*	14.45	31.94	----	----
4/17/2011	2042	DITCH C*	15.19	31.96	----	----
4/17/2011	----	DITCH B*	**Inaccessible**			
4/18/2011	0915	WETLAND A*	14.88	31.96	----	----
4/18/2011	1032	WETLAND B*	14.52	31.96	----	----
4/18/2011	1200	WETLAND C*	14.74	31.96	----	----
4/18/2011	2021	WETLAND A*	15.42	31.98	----	----
4/18/2011	2144	WETLAND B*	16.04	31.98	----	----
4/17/2011	2154	WETLAND C*	15.82	31.94	----	----
7/17/2011	1032	WETLAND A	21.90	20.25	7.39	8.12
7/17/2011	1213	WETLAND B	24.72	26.60	7.40	7.99
7/17/2011	1334	WETLAND C	26.01	20.73	9.35	8.14

Ichthyofauna Sampling						
Date	**Time**	**Location**	**Temp (ºC)**	**Salinity (ppt)**	**DO (mg/L)**	**pH**
7/17/2011	2041	WETLAND A	21.50	33.75	7.56	8.13
7/17/2011	2220	WETLAND B	22.91	29.84	5.95	8.70
7/17/2011	2357	WETLAND C	23.33	29.77	9.86	8.39
7/18/2011	1049	DITCH A	22.10	34.22	--------	7.79
7/18/2011	--------	DITCH B	**Inaccessible**			
7/18/2011	1220	DITCH C	29.94	14.41	14.56	8.50
7/18/2011	2109	DITCH A	25.02	33.72	5.03	7.68
7/18/2011	2216	DITCH B	24.72	33.58	3.14	7.67
7/18/2011	2258	DITCH C	20.93	26.60	2.21	7.82

*water conditions taken from SCOOS (http://www.sccoos.org) at Santa Monica Pier

**water conditions taken from YSI 6600 permanent data sonde at main tide gate

Benthic Invertebrate Sampling						
Date	**Time**	**Location**	**Temp (ºC)**	**Salinity (ppt)**	**DO (mg/L)**	**pH**
4/26/2011	1051	BW1	24.54	20.07	16.43	8.01
4/26/2011	1117	BW2	24.09	23.76	17.97	8.18
4/26/2011	1212	BW8	27.91	14.49	9.30	8.43
4/27/2011	1143	BW4	21.84	29.52	13.75	8.46
4/27/2011	1203	BW5	**Too shallow for accurate readings**			
4/27/2011	1223	BW6	**Too shallow for accurate readings**			
4/27/2011	1251	BW7	**Too shallow for accurate readings**			
10/26/2010	1645	BW1	21.47	29.33	12.44	8.13
10/26/2010	1610	BW2	22.22	0.19	11.49	7.67
10/26/2010	1430	BW8	19.88	21.57	10.97	7.58
11/1/2010	1130	BW4	18.92	15.32	9.15	6.74
11/1/2010	0955	BW5	15.72	26.99	8.23	6.41
11/1/2010	1040	BW6	12:10	20.70	18.32	8.07
11/1/2010	1210	BW7	16.80	23.96	7.21	6.57

Marine Sediment Sampling						
Date	**Time**	**Location**	**Temp (ºC)**	**Salinity (ppt)**	**DO (mg/L)**	**pH**
3/30/2011	1426	BW1	29.61	21.77	25.36	8.47

Marine Sediment Sampling						
Date	**Time**	**Location**	**Temp (ºC)**	**Salinity (ppt)**	**DO (mg/L)**	**pH**
3/30/2011	1514	BW4	28.07	20.73	13.11	8.34
3/30/2011	1540	BW5	**Too shallow for accurate readings**			
3/30/2011	1250	BW6	23.17	24.67	15.39	8.07
3/30/2011	1622	BW7	--------	26.2	7.87	7.85
3/30/2011	1348	BW8	25.53	3.18	31.73	31.73
3/30/2011	1221	BW9	21.16	7.34	19.77	8.23

Dissolved Metals Sampling						
Date	**Time**	**Location**	**Temp (ºC)**	**Salinity (ppt)**	**DO (mg/L)**	**pH**
1/25/2011	1255	BW1	14.03	15.31	9.90	6.73
1/25/2011	1305	BW3	16.22	25.57	12.78	8.17
1/25/2011	1325	BW5	17.23	25.98	11.26	8.18
1/25/2011	1334	BW6	16.51	25.34	10.38	8.24
1/25/2011	1342	BW4	15.80	27.92	9.93	8.14
1/25/2011	1349	BW7	16.77	25.74	9.59	8.08
1/25/2011	1400	BW8	16.72	25.18	11.06	8.18

APPENDIX A.2: **Raw data constituent values for elements assessed on 26 January 2011.**

Note: zeros represent data points that were too small for an accurate reading

ELEMENTS	BW 1 (ppb)	BW3 (ppb)	BW4 (ppb)	BW5 (ppb)	BW6 (ppb)	BW7 (ppb)	BW8 (ppb)
phosphorus	1190.2	1038.9	1028.8	363.4	440.6	312.7	356.4
iron	0.0	0.0	12.6	41.7	13.9	157.7	227.5
manganese	43.1	26.3	20.0	28.6	27.3	42.5	27.6
zinc	58.3	56.5	228.1	52.0	132.6	142.7	53.0
copper	79.7	7.1	128.4	29.7	26.7	30.1	42.8
boron	3452.0	2533.4	2829.7	2639.5	2548.5	2735.7	2509.5
magnesium	1220315.5	978261.6	1021690.4	965814.6	966557.1	973374.6	911825.8
sulfur	931402.3	746852.0	782701.0	744767.6	750436.6	761185.5	720605.6
molybdenum	6.8	0.0	0.0	0.0	0.0	0.0	0.0
aluminum	0.0	0.0	0.0	0.0	0.0	0.0	0.0
arsenic	21.3	0.0	0.0	18.3	0.0	0.0	18.5
barium	153.4	66.7	84.6	22.3	31.4	57.5	60.0
cadmium	58.0	23.5	36.5	36.5	15.1	28.9	41.5
chromium	0.0	0.0	0.0	0.0	0.0	0.0	0.0
cobalt	49.8	104.8	63.1	0.0	43.0	97.9	134.4
lead	91.7	0.0	0.0	0.0	147.3	0.0	0.0
lithium	569.9	467.0	480.2	448.2	458.6	446.2	416.5
mercury	0.0	0.0	0.0	0.0	0.0	0.0	0.0
nickel	0.0	11.3	575.2	3.3	0.0	0.0	0.0
selenium	1286.3	1142.9	262.6	572.3	976.4	431.4	358.2
silicon	232.5	407.2	448.6	721.5	532.5	946.7	1097.8
silver	2.3	0.0	0.0	0.0	0.0	0.0	0.0
strontium	7213.3	5866.6	6182.8	5907.3	5954.0	6083.9	5772.4
tin	31.9	16.1	30.7	45.7	0.0	33.5	0.0
titanium	0.0	0.0	0.0	0.0	0.0	1.9	0.0
vanadium	10.2	6.1	0.0	31.2	29.3	26.5	35.3
pH	7.81	8.18	8.04	8.11	8.10	8.00	8.10
ECw (dS/m)	48.80	39.30	42.40	39.90	40.00	39.90	38.90
bicarbonate	200	186	168	188	177	238	223
nitrate as N	80	66	72	72	77	79	72
chloride	18,478	14,178	15,143	13,831	13,833	13,653	13,642
SAR	56.4	49.3	52.5	49.3	50.1	49.4	50.8
Adjusted SAR	133.4	111.4	117.0	111.7	112.2	117.8	118.4
water hardness	5,995	4,851	5,054	4,799	4,799	4,864	4,559

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Photo credit: E. Tuttle

CHAPTER 2:
MARINE SEDIMENT

Ballona Wetlands Ecological Reserve, Los Angeles, California
Santa Monica Bay Restoration Commission

Prepared for: California State Coastal Conservancy
June 2012

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MARINE SEDIMENT

INTRODUCTION

Urban wetlands can be contaminated by a wide variety of constituents and sources (Comeleo et al. 1996, Bay et al. 2010). Contamination within marine sediments can be an indication of poor water quality (López-Florez et al. 2003). While water quality parameters may change with seasonal and daily fluctuations in inputs, contaminant levels in sediments show less variation and may indicate contamination of an ecological system (Lau and Chu 2000).

Identification and assessment of sediment toxicity levels are important to understanding wetland systems, as sediment contamination can result in significant impacts to wetland ecological processes (Lau and Chu 2000, Greaney 2005). Impacts can take the form of directly contaminating plants or animals through uptake or ingestion, or by affecting reproductive capabilities, organism function, and bioaccumulation (Thompson and Lowe 2004). Trace metals can also be used as indicators of other pollutants to which they are potentially related (Greaney 2005).

The goal of the marine sediment surveys for the Baseline Assessment Program (BAP) at the Ballona Wetlands Ecological Reserve (BWER) was to assess sediment toxicity by evaluating constituents of concern within the tidal channels of Area B and the Fiji Ditch.

METHODS

Site Locations and Times

One sampling station (BW1) was located in the Fiji Ditch, and six stations were located in the tidal channels of Area B (BW4-9) for sample collection during the second baseline year (Figure 2.1). Stations were selected to collect sediment quality data which encompassed the greatest diversity of conditions at the BWER. Sediment sampling stations coincided with water quality, benthic invertebrate, and first baseline year sediment sampling locations. For the second baseline year, one station was added (BW9) and one station was removed (BW2) to capture the greatest variability possible on site. Sediment quality samples were collected at each sampling station once on 30 March 2011.

Figure 2.1. Map of sediment sampling stations within the BWER.

Field Methods

Detailed methods for the first year of sediment samples collected on 26 March 2010 can be found in Chapter 2: Marine Sediment of the Baseline Assessment Report: 2009-2010 (Johnston et al. 2011). The second baseline year sediment samples were collected using individual sterile scoops, syringes, and gloves to a depth of approximately 10 cm at each station. Sediment was placed in sealed sterile glass jars, vials, and 1-liter plastic bottles with an attached chain of custody form and signatures.

Analysis Methods

The first baseline year samples were processed by Wallace Laboratories, Inc, using a gentle extraction method (extractable ammonium bicarbonate diethylene triamine pentoacetic acid or DTPA), to assess bioavailability of trace metals within the sediments. Detailed laboratory and processing methods can be found in Chapter 3: Terrestrial Soils of the first year baseline report (Johnston et al. 2011).

The second year samples were processed using an acid digestion method to evaluate the soluble, exchangeable, and bulk mineral forms of the metals for comparison. Second year sediment samples were processed and analyzed by IIRMES laboratory, California State University, Long Beach, according to EPA certified methods (Table 2.1). Potential laboratory contamination during sample processing and analysis was monitored through the analysis of procedural blanks at a minimum frequency of one per batch (20 samples per batch maximum). Accuracy and precision were defined through a combination of spikes and reference or duplicate materials. Sediment samples were analyzed for grain size, total organic carbon (TOC), trace metals, and mercury (Table 2.1).

Table 2.1. Constituents and assessment methods evaluated in the second baseline year.

Constituent	**Assessment Method**
Trace metals	ICPMS using Method EPA 6020m
Mercury (Hg)	CVAFS using Method 245.7m
Grain size (Clay: <0.0039mm; Silt: 0.0039 to <0.0625mm; Sand: 0.0625 to <2.0mm)	Method SM 2560
Total Organic Carbon	Method SM 5310 B

Amphipod toxicity was conducted using *Eohaustorius estuarius* 10-day survival sediment bioassay under guidelines prescribed in *Methods for Assessing the Toxicity of Sediment-associated Contaminants with Estuarine and Marine Amphipods, EPA/600/R-94/025.* Five repetitions were assessed for each station.

Values were compared against Effects Range Low (ERL) limits (USEPA 1996). Stations that were not duplicated both years were removed for the comparison analyses (i.e. BW2 from the first baseline year and BW9 from the second).

RESULTS

Grain Size and Total Organic Carbon Results

The dominant grain size varied by station (Figure 2.2). Stations BW1 (48.1%), BW4 (45.6%), and BW8 (63.6%) were dominated by sandy sediments; stations BW5 (56.8%), BW6 (50.4%), BW7 (58.2%), and BW9 (49.2%) were dominated by silty sediment.

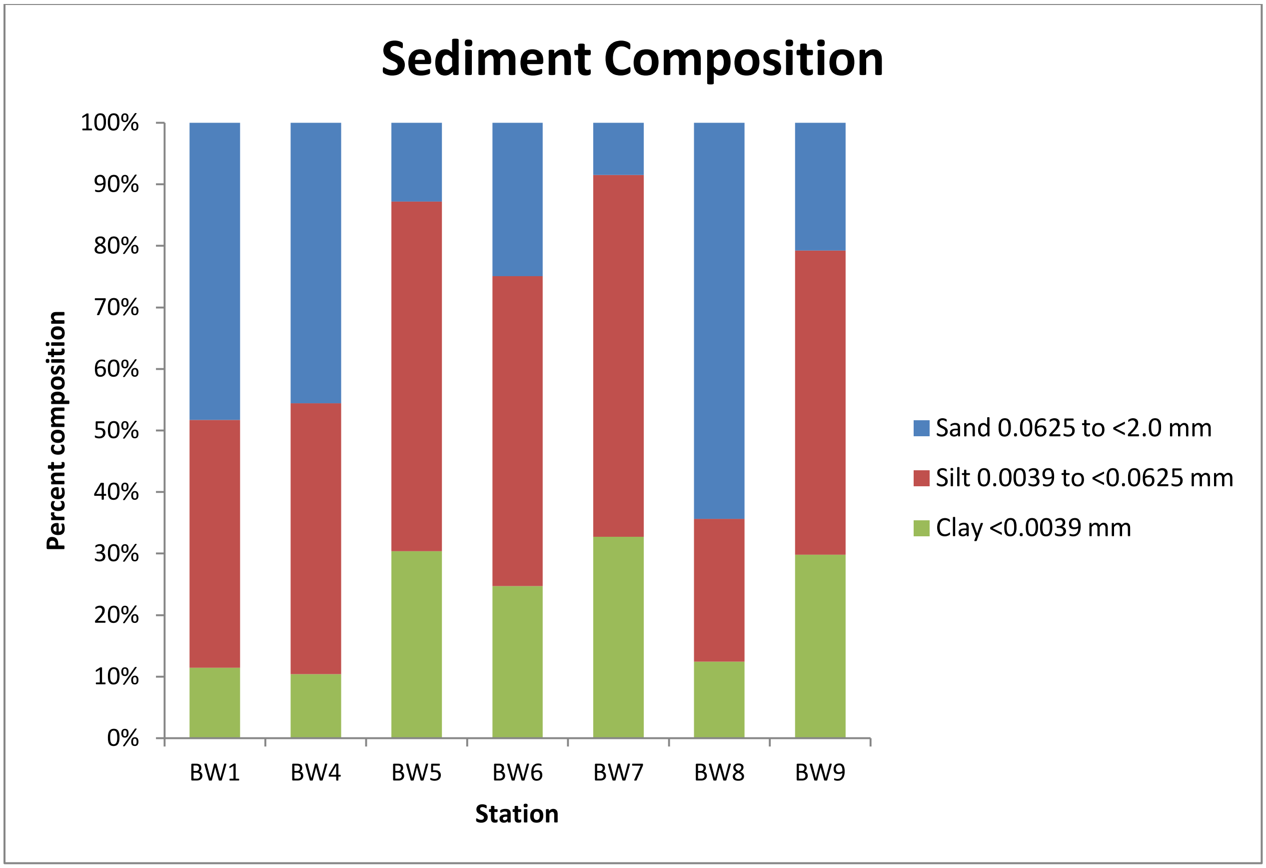

Figure 2.2. Sediment composition by station.

The station with the highest TOC percent dry weight was BW8 (Table 2.2). BW1 had the lowest TOC percent dry weight of all stations evaluated. TOC ranged from 0.94-4.95% dry weight.

Table 2.2. Total organic carbon (% dry weight) in sediment samples at each station.

Sample #	Result
BW1	0.94
BW4	1.7
BW5	3.35
BW6	2.95
BW7	1.9
BW8	4.95
BW9	1.74

Trace Metals and Elements Results

Trace metals were evaluated against ERL limits (USEPA 1996). One station (BW8) and one constituent (lead) had exceedances in the first baseline year (Table 2.3; Appendix B.1). All stations in the second baseline year trace metals and elements results had at least one metal exceedance (Figure 2.3; Appendix B.2) using the strong acid digestion. BW5, BW7, and BW9 exceeded limits for all elements evaluated (i.e. arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver, and zinc). BW1 and BW8 exceeded for one metal each (copper and lead, respectively). Copper and lead exceeded limits at 6 stations each. Nickel and zinc exceed limits at 5 stations (all stations except BW1 and BW8). Cadmium, mercury and silver exceeded ERL's at the lowest number of stations (BW5, BW7, and BW9; these stations exceeded in every metal). Silver was the only constituent to be non-detectable (ND) at one station (BW1).

During the second year of sampling, exceedances at BW9 were highest for every constituent across all stations except for zinc. Zinc had the largest margin of exceedance at BW7 (2.03 times the limit). BW9 had a minimum of 2.53 times the limit for every constituent. The maximum exceedance was BW9 which had 10.31 times the limit for lead. Lead and copper exceeded by the largest margin at the highest number of stations. Lead was between 1.28 and 10.31 times the limit at 6 stations. Copper was between 1.48 and 3.25 times the limit at 6 stations. Mercury exceeded at BW5, BW7, and BW9 (Figure 2.3), but was within 0.02 ppm of the exceedance limit for three additional stations (BW4, BW6, and BW8).

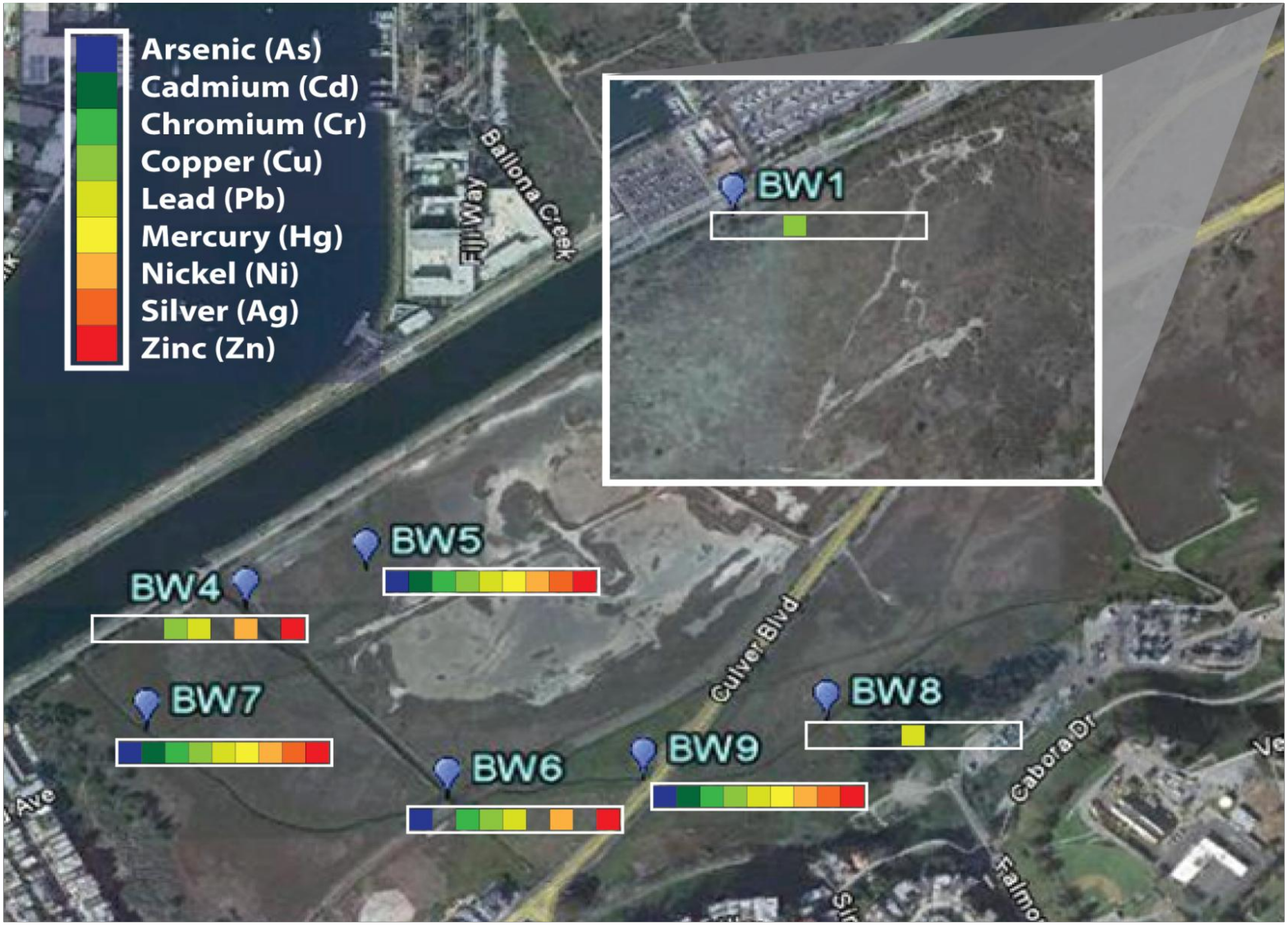

Figure 2.3. Constituents exceeding ERL numeric limits at BWER stations in the second baseline year.

Table 2.3. Value of constituents (ppm) for each station, element, and year; values in red exceeded ERL limits. Note: * denotes a value within 0.03ppm of ERL limit for that constituent.

	Station	Arsenic (As)	Cadmium (Cd)	Chromium (Cr)	Copper (Cu)	Lead (Pb)	Mercury (Hg)	Nickel (Ni)	Silver (Ag)	Zinc (Zn)
Year 1	**BW1**	0.05	0.02	0	0.13	2.93	0	0.47	0	2.24
	BW4	0.31	0.06	0	0.04	12.53	0	0.49	0	1.99
	BW5	0.48	0.12	0	0.11	16.3	0	0.85	0	2.21
	BW6	0.5	0.05	0.03	0.86	16.46	0	0.21	0	2.68
	BW7	1.18	0.14	0	0.13	4.03	0	0.83	0	0.78
	BW8	0.87	0.1	0.13	1.21	**56.47**	0	0.89	0	11.74
	Exceedances					*BW8*				
Year 2	**BW1**	4.6	0.49	38.9	**60**	23.1	0.07	17.1	0.00	130.1
	BW4	5.67	0.74	60.7	**50.4**	**59.6**	0.14*	**25.9**	0.61	**176**
	BW5	**10.84**	**1.66**	**89.54**	**76.8**	**105.4**	**0.2**	**37.44**	**2.25**	**238.2**
	BW6	**10.55**	0.84	**82.67**	**50.83**	**65.57**	0.13*	**29.11**	0.5	**172.5**
	BW7	**12.25**	**1.27**	**97.2**	**84.05**	**104.9**	**0.21**	**39.29**	**2**	**304.9**
	BW8	5.3	1.20*	40.15	28.74	**74.05**	0.14*	13.1	0.63	129.7
	Exceedances	*BW5, BW6, BW7*	*BW5, BW7*	*BW5, BW6, BW7*	*BW1, BW4, BW5, BW6, BW7*	*BW4, BW5, BW6, BW7, BW8*	*BW5, BW7*	*BW4, BW5, BW6, BW7*	*BW5, BW7*	*BW4, BW5, BW6, BW7*
	ERL	**8.2**	**1.2**	**81**	**34**	**46.7**	**0.15**	**20.9**	**1**	**150**

ERL = Effects Range Low (USEPA 1996)

Amphipod Toxicity Results

Table 2.4 displays summary data from the amphipod, *Eohaustorius estuarius,* toxicity 10-day survival sediment bioassay testing. Two stations (BW4 and BW9) had confirmed 'low toxicity' results (CRWQCB and USEPA 2005; ASTM 2006). The rest of the stations had 92% or higher survival.

Table 2.4. Summary data from the amphipod toxicity testing. Significantly toxic results are identified with red print.

Station	Survival	F value	p value	Significant Effect	Soil Toxicity
BW1	96.0%	0.5698	0.4720	No	N/A
BW4	87.0%	8.5650	0.0191	Yes	low toxicity
BW5	95.0%	0.1419	0.7162	No	N/A
BW6	88.0%	4.2800	0.0723	No	N/A
BW7	94.0%	0.0000	1.0000	No	N/A
BW8	92.0%	0.3018	0.5977	No	N/A
BW9	82.0%	13.8000	0.0059	Yes	low toxicity

ANALYSIS OF BASELINE RESULTS

The acid digestion method of measuring metals in sediment (second year; Appendix B.2) provided different results than the bioavailable extraction method (DTPA, first year; Appendix B.1). Acid digestion is an USEPA standard method for assessing metals in sediment and is a stronger digestion method than the DTPA method. Many of the trace metals were not detectable using the bioavailable method, but had high values when assessed using the acid digestion. Further analyses should include this method for assessing toxicity, especially for samples with lower concentration ranges (non-detect for the bioavailable method), and the bioavailable method when comparing to plant tissues.

Overall, metals were high (when compared to ERLs) in many sediment samples, but the amphipod toxicity rates were low. This indicates that while the metals may be high enough to be chronically toxic over time, they are likely not acutely toxic for marine invertebrates in the samples surveyed. Additional analyses in the Ballona Creek estuary will continue to be conducted by the City of Los Angeles, to monitor the progress of the sediment toxicity TMDL.

FUTURE DIRECTIONS

No additional studies are planned for the third year of monitoring. Additional constituents may be tested pending funding availability.

APPENDIX B.1

Values for trace metals and constituents at marine sediment stations during first baseline year

NOTE: Values are recorded in ppm unless otherwise noted.

	STATIONS						
ELEMENTS	**BW1**	**BW2**	**BW4**	**BW5**	**BW6**	**BW7**	**BW8**
phosphorus	9.03	9.01	14.82	19.16	13.90	31.96	35.52
potassium	406.99	1,336.74	1,181.04	2,143.39	821.22	2,829.96	964.56
iron	239.79	785.50	641.46	826.60	122.31	1,033.83	283.97
manganese	6.71	5.54	5.10	2.55	10.57	2.93	44.36
zinc	2.24	2.83	1.99	2.21	2.68	0.78	11.74
copper	0.13	0.09	0.04	0.11	0.86	0.13	1.21
boron	1.98	5.20	4.52	7.69	2.73	10.09	4.36
calcium	161.95	165.75	351.21	457.26	177.77	1,150.72	261.31
magnesium	537.24	1,699.59	1,520.86	2,631.74	984.77	3,891.09	1,304.53
sodium	3,770.75	10,223.34	10,501.58	16,638.01	6,162.20	24,784.26	8,186.74
sulfur	284.23	1,078.57	890.61	1,108.06	556.31	2,225.01	657.22
molybdenum	0.05	0.58	0.59	0.51	0.31	0.25	0.42
nickel	0.47	0.39	0.49	0.85	0.21	0.83	0.89
aluminum	14.24	55.49	42.86	53.10	4.85	63.48	11.17
arsenic	0.05	0.10	0.31	0.48	0.50	1.18	0.87
barium	0.02	0.03	0.03	0.07	0.03	0.12	0.06
cadmium	0.02	0.07	0.06	0.12	0.05	0.14	0.10
chromium	0.0	0.0	0.0	0.0	0.03	0.0	0.13
cobalt	0.06	0.12	0.09	0.09	0.08	0.12	0.26
lead	2.93	9.53	12.53	16.30	16.46	4.03	56.47
lithium	0.22	0.44	0.60	0.99	0.36	1.64	0.42
mercury	0.0	0.0	0.0	0.0	0.0	0.0	0.0
selenium	0.0	0.13	0.0	0.30	0.03	0.0	0.42
silver	0.0	0.0	0.0	0.0	0.0	0.0	0.0
strontium	2.09	1.59	6.15	9.50	2.32	21.78	4.43
tin	0.0	0.0	0.0	0.0	0.0	0.0	0.0
vanadium	1.07	2.96	2.38	3.97	2.25	4.24	3.61
pH value	7.39	7.52	7.24	7.34	7.41	7.25	7.64
ECe (milli- mho/cm)	42.30	30.40	34.20	38.10	39.20	39.20	26.20
calcium	472.2	246.2	277.4	318.5	313.6	324.4	218.9
magnesium	968.1	696.0	792.1	919.4	915.0	995.4	600.3
sodium	7,652.8	5,745.0	6,096.8	6,931.8	6,844.6	7,349.9	4,649.4
potassium	340.6	229.3	262.0	311.3	305.9	314.8	199.2
chloride	14,646	10,412	11,612	13,459	12,748	14,210	8,400
nitrate as N	89	51	59	70	70	71	45
phosphorus as P	1.7	0.0	0.0	0.0	0.0	2.7	1.4
sulfate as S	731.1	587.0	557.1	669.9	617.6	630.2	434.2
boron as B	3.48	2.38	2.07	2.93	3.21	3.03	2.10

APPENDIX B.2

Values for trace metals at marine sediment stations during second baseline year

Note: Constituents are recorded as ppm unless otherwise noted.

INSTITUTE FOR INTEGRATED RESEARCH IN MATERIALS, ENVIRONMENTS & SOCIETY

California State University, Long Beach, 1250 Bellflower Blvd., Long Beach, CA 90840 (562-985-2469)

Trace Metals

ANALYTICAL REPORT

Analyte	Fraction	Result	MDL	RL	Units	Batch	Prepared	Analyzed	Method	QA Code
3943-R1 **BW1**					**Sediment**	**Sampled: 3/30/2011**	**14:33**		**Received: 31-Mar-11**	
Aluminum (Al)	NA	41280	1	5	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Antimony (Sb)	NA	0.77	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Arsenic (As)	NA	4.6	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Barium (Ba)	NA	592.2	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Beryllium (Be)	NA	1.27	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Cadmium (Cd)	NA	0.49	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Chromium (Cr)	NA	38.9	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Cobalt (Co)	NA	8.98	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Copper (Cu)	NA	60	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Iron (Fe)	NA	30890	1	5	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Lead (Pb)	NA	23.1	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Manganese (Mn)	NA	514.8	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Mercury (Hg)	NA	0.07	0.01	0.02	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 245.7m	
Molybdenum (Mo)	NA	1.74	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Nickel (Ni)	NA	17.1	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Selenium (Se)	NA	0.36	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Silver (Ag)	NA	ND	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Strontium (Sr)	NA	245.6	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Thallium (Tl)	NA	0.43	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Tin (Sn)	NA	2.16	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Titanium (Ti)	NA	3490	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Vanadium (V)	NA	74.2	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Zinc (Zn)	NA	130.1	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
3944-R1 **BW4**					**Sediment**	**Sampled: 3/30/2011**	**15:21**		**Received: 31-Mar-11**	

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Trace Metals

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Analyte	Fraction	Result	MDL	RL	Units	Batch	Prepared	Analyzed	Method	QA Code
Aluminum (Al)	NA	62230	1	5	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Antimony (Sb)	NA	1.39	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Arsenic (As)	NA	5.67	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Barium (Ba)	NA	355.6	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Beryllium (Be)	NA	1.47	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Cadmium (Cd)	NA	0.74	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Chromium (Cr)	NA	60.7	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Cobalt (Co)	NA	14	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Copper (Cu)	NA	50.4	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Iron (Fe)	NA	46320	1	5	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Lead (Pb)	NA	59.6	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Manganese (Mn)	NA	580.2	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Mercury (Hg)	NA	0.14	0.01	0.02	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 245.7m	
Molybdenum (Mo)	NA	3.14	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Nickel (Ni)	NA	25.9	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Selenium (Se)	NA	0.63	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Silver (Ag)	NA	0.61	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Strontium (Sr)	NA	156.7	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Thallium (Tl)	NA	0.63	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Tin (Sn)	NA	5.99	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Titanium (Ti)	NA	5077	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Vanadium (V)	NA	97.4	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Zinc (Zn)	NA	176	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	

3945-R1 **BW5** **Sediment** **Sampled: 3/30/2011** **15:43** **Received: 31-Mar-11**

Analyte	Fraction	Result	MDL	RL	Units	Batch	Prepared	Analyzed	Method	QA Code
Aluminum (Al)	NA	72140	1	5	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Antimony (Sb)	NA	1.99	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	

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Analyte	Fraction	Result	MDL	RL	Units	Batch	Prepared	Analyzed	Method	QA Code
Arsenic (As)	NA	10.84	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Barium (Ba)	NA	363.9	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Beryllium (Be)	NA	1.61	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Cadmium (Cd)	NA	1.66	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Chromium (Cr)	NA	89.54	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Cobalt (Co)	NA	14.88	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Copper (Cu)	NA	76.8	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Iron (Fe)	NA	46560	1	5	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Lead (Pb)	NA	105.4	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Manganese (Mn)	NA	394.9	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Mercury (Hg)	NA	0.2	0.01	0.02	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 245.7m	
Molybdenum (Mo)	NA	6.28	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Nickel (Ni)	NA	37.44	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Selenium (Se)	NA	3.22	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Silver (Ag)	NA	2.25	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Strontium (Sr)	NA	252.8	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Thallium (Tl)	NA	0.64	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Tin (Sn)	NA	6.49	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Titanium (Ti)	NA	5006	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Vanadium (V)	NA	132.4	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Zinc (Zn)	NA	238.2	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	

3946-R1 BW6 Sediment Sampled: 3/30/2011 12:55 Received: 31-Mar-11

Analyte	Fraction	Result	MDL	RL	Units	Batch	Prepared	Analyzed	Method	QA Code
Aluminum (Al)	NA	47340	1	5	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Antimony (Sb)	NA	1.66	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Arsenic (As)	NA	10.55	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Barium (Ba)	NA	303	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	

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California State University, Long Beach, 1250 Bellflower Blvd., Long Beach, CA 90840 (562-985-2469)

Trace Metals

ANALYTICAL REPORT

Analyte	Fraction	Result	MDL	RL	Units	Batch	Prepared	Analyzed	Method	QA Code
Beryllium (Be)	NA	1.8	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Cadmium (Cd)	NA	0.84	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Chromium (Cr)	NA	82.67	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Cobalt (Co)	NA	14.51	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Copper (Cu)	NA	50.83	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Iron (Fe)	NA	52000	1	5	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Lead (Pb)	NA	65.57	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Manganese (Mn)	NA	832.3	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Mercury (Hg)	NA	0.13	0.01	0.02	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 245.7m	
Molybdenum (Mo)	NA	4.85	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Nickel (Ni)	NA	29.11	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Selenium (Se)	NA	2.15	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Silver (Ag)	NA	0.5	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Strontium (Sr)	NA	246.7	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Thallium (Tl)	NA	0.46	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Tin (Sn)	NA	6.22	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Titanium (Ti)	NA	10630	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Vanadium (V)	NA	145.2	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Zinc (Zn)	NA	172.5	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	

3947-R1 BW7 Sediment Sampled: 3/30/2011 16:15 Received: 31-Mar-11

Analyte	Fraction	Result	MDL	RL	Units	Batch	Prepared	Analyzed	Method	QA Code
Aluminum (Al)	NA	75190	1	5	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Antimony (Sb)	NA	2.1	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Arsenic (As)	NA	12.25	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Barium (Ba)	NA	357.9	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Beryllium (Be)	NA	1.57	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Cadmium (Cd)	NA	1.27	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	

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Analyte	Fraction	Result	MDL	RL	Units	Batch	Prepared	Analyzed	Method	QA Code
Chromium (Cr)	NA	97.2	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Cobalt (Co)	NA	15.43	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Copper (Cu)	NA	84.05	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Iron (Fe)	NA	47440	1	5	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Lead (Pb)	NA	104.9	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Manganese (Mn)	NA	346.5	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Mercury (Hg)	NA	0.21	0.01	0.02	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 245.7m	
Molybdenum (Mo)	NA	4.57	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Nickel (Ni)	NA	39.29	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Selenium (Se)	NA	2.27	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Silver (Ag)	NA	2	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Strontium (Sr)	NA	215.1	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Thallium (Tl)	NA	0.59	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Tin (Sn)	NA	7.32	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Titanium (Ti)	NA	4678	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Vanadium (V)	NA	139.4	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Zinc (Zn)	NA	304.9	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	

3948-R1 BW8 Sediment Sampled: 3/30/2011 13:55 Received: 31-Mar-11

Analyte	Fraction	Result	MDL	RL	Units	Batch	Prepared	Analyzed	Method	QA Code
Aluminum (Al)	NA	28010	1	5	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Antimony (Sb)	NA	1.05	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Arsenic (As)	NA	5.3	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Barium (Ba)	NA	234.2	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Beryllium (Be)	NA	0.85	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Cadmium (Cd)	NA	1.2	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Chromium (Cr)	NA	40.15	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Cobalt (Co)	NA	6.67	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	

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Analyte	Fraction	Result	MDL	RL	Units	Batch	Prepared	Analyzed	Method	QA Code
Copper (Cu)	NA	28.74	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Iron (Fe)	NA	15890	1	5	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Lead (Pb)	NA	74.05	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Manganese (Mn)	NA	206.9	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Mercury (Hg)	NA	0.14	0.01	0.02	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 245.7m	
Molybdenum (Mo)	NA	3.23	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Nickel (Ni)	NA	13.1	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Selenium (Se)	NA	1.79	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Silver (Ag)	NA	0.63	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Strontium (Sr)	NA	206.5	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Thallium (Tl)	NA	0.36	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Tin (Sn)	NA	3.99	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Titanium (Ti)	NA	2026	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Vanadium (V)	NA	42.66	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Zinc (Zn)	NA	129.7	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	

3949-R1 **BW9** **Sediment** **Sampled: 3/30/2011 12:27** **Received: 31-Mar-11**

Analyte	Fraction	Result	MDL	RL	Units	Batch	Prepared	Analyzed	Method	QA Code
Aluminum (Al)	NA	39310	1	5	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Antimony (Sb)	NA	1.77	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Arsenic (As)	NA	11.78	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Barium (Ba)	NA	272.4	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Beryllium (Be)	NA	1.43	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Cadmium (Cd)	NA	1.82	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Chromium (Cr)	NA	96.45	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Cobalt (Co)	NA	13.82	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Copper (Cu)	NA	60.12	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Iron (Fe)	NA	35920	1	5	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	

INSTITUTE FOR INTEGRATED RESEARCH IN MATERIALS, ENVIRONMENTS & SOCIETY

California State University, Long Beach, 1250 Bellflower Blvd., Long Beach, CA 90840 (562-985-2469)

Trace Metals

ANALYTICAL REPORT

Analyte	Fraction	Result	MDL	RL	Units	Batch	Prepared	Analyzed	Method	QA Code
Lead (Pb)	NA	265.4	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Manganese (Mn)	NA	384.7	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Mercury (Hg)	NA	0.19	0.01	0.02	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 245.7m	
Molybdenum (Mo)	NA	4.14	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Nickel (Ni)	NA	31.93	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Selenium (Se)	NA	0.78	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Silver (Ag)	NA	1.5	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Strontium (Sr)	NA	188.5	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Thallium (Tl)	NA	0.52	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Tin (Sn)	NA	5.7	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Titanium (Ti)	NA	5086	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Vanadium (V)	NA	116.2	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	
Zinc (Zn)	NA	206.8	0.025	0.05	µg/dry g	M01-123	4/11/2011	4/12/2011	EPA 6020m	

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CHAPTER 3:
TERRESTRIAL SOILS

Ballona Wetlands Ecological Reserve, Los Angeles, California
Santa Monica Bay Restoration Commission

Prepared for: California State Coastal Conservancy
June 2012

Author: Karina Johnston

TERRESTRIAL SOILS

INTRODUCTION

Human activities pose considerable risks (Hooper and Anderson 2009) and impacts (Cardelli et al. 2012) to soil systems, so it is important to understand the influences of those activities on the environment. During the first baseline year, the Baseline Assessment Program (BAP) conducted the first comprehensive ecologically-based surface terrestrial soil survey across the Ballona Wetlands Ecological Reserve (BWER). Terrestrial ecotoxicity was assessed by determining phytoavailable constituents of concern (Kabata-Pendias 2004, NOAA 2010) within BWER soils across the site, comparing these trace elements across habitat types, and evaluating the constituent values against ecological soil criteria for plants (EPA 2005).

During the second baseline year, the goals of the terrestrial soil assessment expanded to include additional parameters that would provide information on pre-restoration conditions of the BWER. These goals included assessing carbon sequestration and analysis of stratification of carbon and other organic matter within cores in disturbed and undisturbed habitats. However, due to permit modifications and restrictions by the California Department of Fish and Game, these surveys were not undertaken during the second baseline year. Pending approval, they may be added in a subsequent monitoring year.

RESULTS

Results for the carbon and organic matter surveys were not completed within year two. For a complete description of the first year ecotoxicity surveys and results, see Chapter 3: Terrestrial Soils from the first Baseline Assessment Report: 2009-2010 (Johnston et al. 2011) and associated appendices (B.2 and B.3).

FUTURE DIRECTIONS

Additional soil surveys along transects surveyed in the first baseline year are proposed for subsequent monitoring years. These surveys would include different parameters such as soil moisture, salinity, grain size, texture, and total organic carbon. These soil properties provide additional information about the quality of the terrestrial soils and some may act as indicators of denitrification processes (Burford and Bremner 1975) and additional ecosystem functions (i.e. organic matter) (Franzluebbers 2002, Carter and Gregorich 2008).

Pending funding availability, future surveys may also include plant tissue analyses for trace metals along the same transects as the soil surveys. This will allow a comparison of the phytoavailability of metals in the surface soils and the uptake by dominant plant species along the transects.

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Photo credit: E. Tuttle

CHAPTER 4:
VEGETATION

Ballona Wetlands Ecological Reserve, Los Angeles, California
Santa Monica Bay Restoration Commission

Prepared for: California State Coastal Conservancy
June 2012

Authors: Karina Johnston, Ivan Medel, Charles Piechowski, and Elena Del Giudice-Tuttle

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VEGETATION

INTRODUCTION

Long-term monitoring of vegetation is one of the most common methods of evaluating the health and functioning of a wetland system (Zedler 2001). Change in the relative presences of native and non-native plant species may affect the distributions of associated wildlife species. For example, the endangered Belding's Savannah Sparrow preferentially utilizes *Salicornia pacifica* (common pickleweed) or other salt marsh related species, including *Distichlis spicata* (saltgrass) and *Arthrocnemum subterminale* (Parish's pickleweed) (Powell 1993, Zembal and Hoffman 2002, James and Stadtlander 1991; E. Read, pers. Comm. 2010) as nesting habitat. Non-native plant species are present throughout the Ballona Wetlands Ecological Reserve (BWER) (PWA 2006); these non-native species are indicators of past disturbances to the wetland and have potentially reduced the value of the site as habitat for native plants and native wildlife (PWA 2006).

Due to the diverse array of vegetation habitats and communities within the BWER, the Baseline Assessment Program (BAP) vegetation surveys are divided into three distinct types: cover surveys, seed bank surveys, and submerged aquatic vegetation (SAV) and algae surveys. The goals of each survey are:

Cover surveys:

1) Determine areas with high non-native species presence;
2) Summarize the prevalence of native and non-native plant cover in each habitat;
3) Define relative species richness (as number of species) by habitat type;
4) Use percent cover to define dominant species in each habitat.

Seed bank surveys:

1) Summarize the occurrence of native and non-native germinated plant seedlings;
2) Define relative species richness of germinated plant seedlings by habitat type;
3) Determine the potential for future recruitment of plant species within habitat types;
4) Evaluate species propagation at a transect level under ideal conditions.

Algae and submerged aquatic vegetation (SAV) surveys:

1) Continue the long-term monitoring program developed by the Southern California Bight Monitoring Program to assess the algal and SAV cover at the BWER;
2) Compare results to other southern California estuaries.

Taxonomic nomenclature for vegetation species changes constantly and is occasionally in dispute. For consistency and accuracy, species are identified using the Jepson Online Interchange California Floristics (Jepson Flora Project; accessed: April 2012). To avoid confusion, plant species are reported within this section first by their scientific and common names and henceforth by their abbreviated scientific name only. Invasive, exotic, and non-native plant species are henceforth referred to as "non-native" throughout this report.

METHODS

Site Locations and Times

Plant surveys were conducted once during the second Baseline year (2010-2011) during the appropriate season for each habitat type (Table 4.1; Zedler 2001) using a stratified sampling design based on habitat types. Transects were repeated from the first year of baseline vegetation surveys to assess temporal (annual) variability. Fewer transects were included in the second year surveys due to similarity among transects within habitat types. A slight reduction of the total number of transects assessed (122 in the second year versus 144 in the first year) allowed for the implementation of adaptive monitoring and the reallocation of resources to additional monitoring strategies.

Field Methods

Field methods for the second year of vegetation surveys were identical to the first baseline year. For detailed methods and maps, refer to Chapter 4 of the Baseline Assessment Program: 2009-2010 Report (Johnston et al. 2011). 122 transects (854 quadrats) across ten habitats were surveyed (Table 4.1). Muted tidal salt marsh habitats were surveyed using the $0.25m^2$ laser quadrat method; the freshwater, brackish, and upland habitats were surveyed using the $1m^2$ cover-class survey method. The cover-class vegetation survey method was based on the Daubenmire (1959) cover-class system using a 7-point scale (Table 4.2).

Table 4.1. BAP vegetation sampling details for habitat types within the BWER.

Habitat	Area	Acres	Transects	Quadrats	Methodology	Survey time
Low marsh	B	8.5	10	70	0.25m²-quadrat sampling along transects & 10m-wide area searches	late summer
Mid-marsh	B	16.4	9	63	0.25m²-quadrat sampling along transects & 10m-wide area searches	late summer
High marsh	B	42.9	11	77	0.25m²-quadrat sampling along transects & 10m-wide area searches	late summer
Seasonal wetland	A, B	74.5	16	112	0.25m²-quadrat sampling along transects & 10m-wide area searches	late summer
Salt pan	B	22.4	5	35	0.25m²-quadrat sampling along transects & 10m-wide area searches	late summer
Freshwater marsh	B	26	5	35	1m-quadrat sampling along transects & 10m-wide area searches	spring
Brackish marsh	B	3.1	5	35	1m-quadrat sampling along transects & 10m-wide area searches	spring
Dune	A, B, C	13	10	70	1m-quadrat sampling along transects & 10m-wide area searches	spring
Upland grassland	A, B, C	176.4	28	196	1m-quadrat sampling along transects & 10m-wide area searches	spring
Upland scrub	A, B, C	92.2	23	161	1m-quadrat sampling along transects & 10m-wide area searches	spring
Unvegetated	B	10.9	----	----	None	----

Table 4.2. Cover categories and associated cover class identification numbers used in the BAP surveys (modified from Daubenmire 1959).

Estimated cover category	Mid point	Cover class
> 0 - 1 %	0.5	1
> 1 - 5 %	3	2
> 5 - 25 %	15	3
> 25 - 50 %	37.5	4
> 50 - 75 %	62.5	5
> 75 - 95 %	85	6
> 95 - 100 %	97.5	7

Analysis Methods

Percent cover for each laser quadrat transect was analyzed as the proportion of points (out of a total of 49) hitting a particular plant species. Percent cover for each cover-class quadrat transect was analyzed using the median of each Daubenmire cover-class category and averaged to determine percent cover within each transect and habitat. Plant cover was averaged by transect and then again by habitat type to analyze the total overall nativity of each habitat; therefore, habitat type averages are grand means. Variability is represented as standard error.

Dominant plant species (>10%) and average percent cover of native and non-native species were reported for each habitat type. Dominant plant species were reported by habitat, using the overall average for each habitat, not as individual transect-level data.

METHODS – SEED BANK SURVEYS

Site Locations and Times

To survey the salt marsh seed bank, soil cores were collected and grown out in a greenhouse and germinated seedlings were identified. Soil cores were collected at ten equally spaced points along 25 m vegetation transects. Two transects were surveyed per habitat [low marsh, mid marsh, high marsh, salt pan, seasonal wetland (Area A), and seasonal wetland (Area B)] for a total of 12 vegetation transects, with four additional 100 m transects from several channel banks. As most wetlands seeds are positively buoyant, the channel banks represent the current seed bank within the wrack lines and are seed accumulation zones. Soil cores were collected during late fall (November – December 2010), after the first rain of the wet season to capture the seed bank at its peak (S. Anderson, pers. Comm. 2009).

Field and Greenhouse Methods

Field and greenhouse methods followed those described in the first Baseline Assessment Report (Chapter 4: Vegetation; Johnston et al. 2011).

Analysis methods

Cores were analyzed by number of germinated seedlings per m^2 and averaged across each habitat type.

METHODS – ALGAE AND SUBMERGED AQUATIC VEGETATION COVER

Site Locations and Times

Algae and submerged aquatic vegetation (SAV) cover surveys (henceforth, ‘algae surveys’) were conducted along four 30 m transects deployed parallel to the channel bank with the same elevation contour as the muted tidal channel. Surveys were conducted four times during the second Baseline year: January, March, June, and September 2011. Surveys were conducted at the same times and locations as the *Cerithidea californica* (California horn snail) sampling (Chapter 9: Benthic invertebrates); SAV and algae were identified to species (Abbot and Hollenberg 1976). Algae surveys were conducted using the same methods and sites as the Southern California Bight ’08 eutrophication surveys (Bight 2008 Wetlands Sub-Committee 2008) and the first year of baseline surveys (Johnston et al. 2011) with the addition of one transect in an area of high algal growth (Transect 4).

Field Methods

Field methods followed those described in the first Baseline Assessment Report (Chapter 4: Vegetation; Johnston et al. 2011). In addition to the tidal creeks, areas with extensive and accessible mudflats where algae are known to accumulate were searched and submerged vegetation within the tidal channels was also noted.

Analysis Methods

Algae surveys were analyzed by determining percent cover for each quadrat (i.e. number of points for a species / 49 x 100). Quadrats were averaged by transect, and standard error was used to determine variability.

RESULTS

General Results and Overall Trends

All vegetation results are preliminary, part of a long term monitoring program, and should be evaluated as such. Data herein are compiled from transect-level cover data and are not considered a full floristic survey of the BWER. Results are analyzed by habitat types derived from the CDFG plant communities survey conducted in 2007 (CDFG 2007). These habitat types were developed for the distinct conditions at BWER and do not necessarily reflect plant habitat types of other southern California wetlands. For example, the low salt marsh habitat type is generally defined by the presence of *Spartina foliosa* (cordgrass) (Zedler et al. 1999), but this vegetation alliance is absent from the BWER.

Overall, 122 vegetation transects were surveyed including 51 in the salt marsh habitat types and 71 in non-salt marsh habitat types (Table 4.3). The floral compendium in Appendix C.1 includes all plant species surveyed or collected within ten meters of all transects. Some taxa were identified to genus, when taxonomic field identification to species was not possible. These plants are identified as ‘*sp*’.

Table 4.3. Total number of transects completed in each habitat.

Salt Marsh Habitats	**# of Transects**		**Non-salt Marsh Habitats**	**# of Transects**
Low salt marsh	10		Brackish marsh	5
Mid salt marsh	9		Freshwater marsh	5
High salt marsh	11		Dune	10
Seasonal wetland (Area A)	6		Upland grassland	28
Seasonal wetland (Area B)	10		Upland scrub	23
Salt pan	5		----	----
TOTAL	**51**		**TOTAL**	**71**

Figure 4.1 displays the average non-native vegetative percent cover across each transect surveyed. Non-native vegetation species dispersal pattern was similar to the first baseline year. All transects in Area C had greater than 10% non-native vegetative cover; nine of 13 transects had greater than 50% non-native cover (69.2% of the Area C transects). All transects in Area A except for two had greater than 10% non-native vegetative cover; two additional transects had cover between 11-25%, and the rest (26 transects) had greater than 26% non-native cover. Conversely, the salt marsh habitats had predominantly native cover. The muted tidal marsh of Area B had a higher percent cover of native plant species than either Area A or C. However, the very southwestern corner of Area B was dominated by *Carpobrotus edulis* (hottentot fig), and often had a range of non-native plant species cover between 76-100%. The salt pan transects had low percentages of vegetative cover; they were primarily bare ground with some native plants.

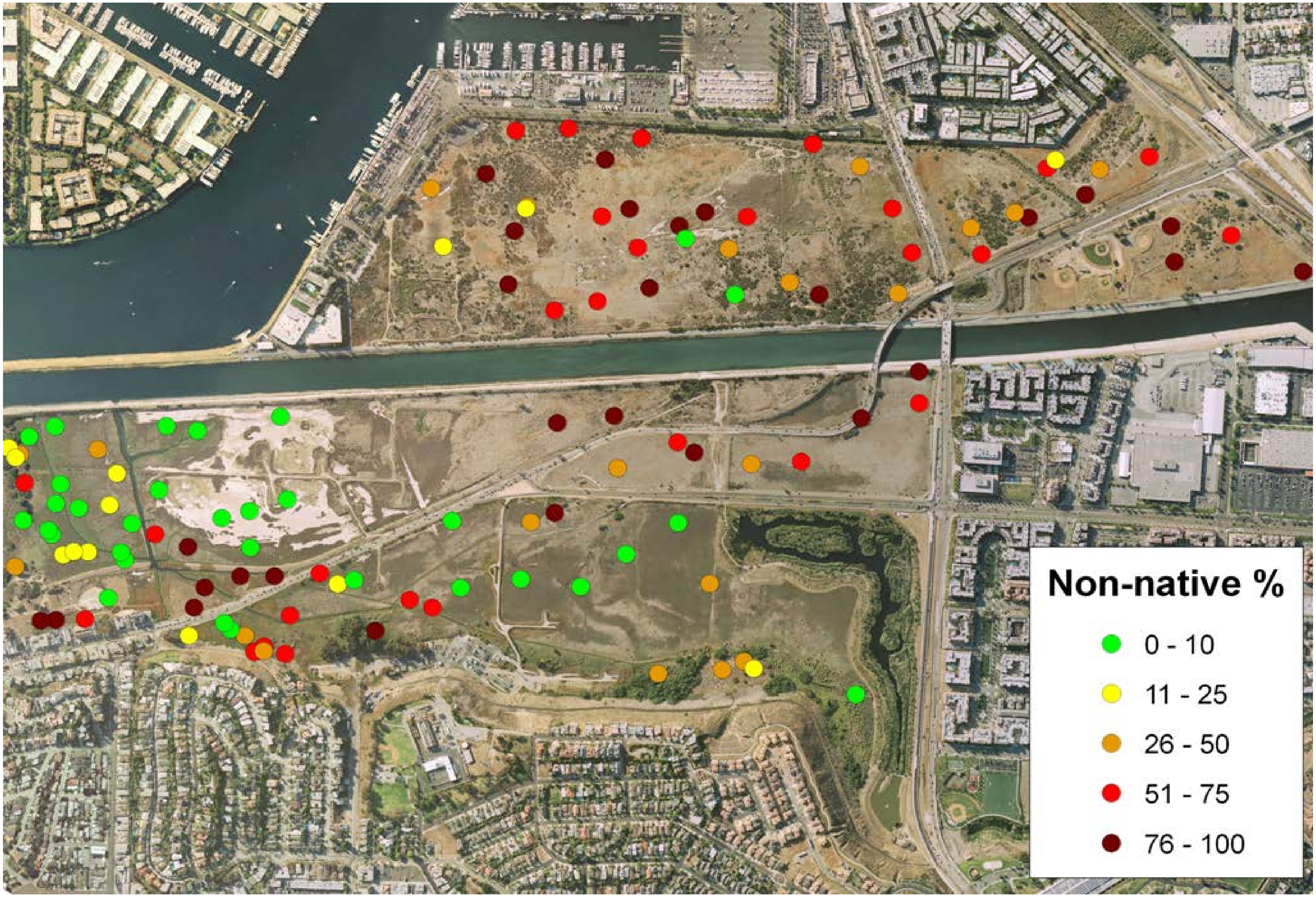

Figure 4.1. Average percent cover of non-native vegetation on each surveyed transect.

Salt Marsh Habitat Results

Results are presented as grand means across the habitat ± standard error (SE). The low salt marsh habitat type had the highest average percent cover of native species at 92.5 ± 2.6% (Figure 4.2), followed by the mid marsh (77.7 ± 8.2%) and the high marsh (65.1 ± 8.8%). The seasonal wetland of Area B also had greater than 50% nativity (56.9 ± 10.9%). Bare ground was highest in the salt pan habitat types followed by the seasonal wetland habitat of Area A (Figure 4.2). The seasonal wetland of Area A had the lowest native percent cover at 12.0 ± 5.5% of all the vegetated salt marsh habitat types and the highest non-native cover (51.6 ± 13.9%). Salt pan habitat had low average vegetation cover for both native and non-native species. Area A seasonal wetland habitats data were analyzed separately from the Area B seasonal wetland habitats because of the difference in plant species composition and elevation.

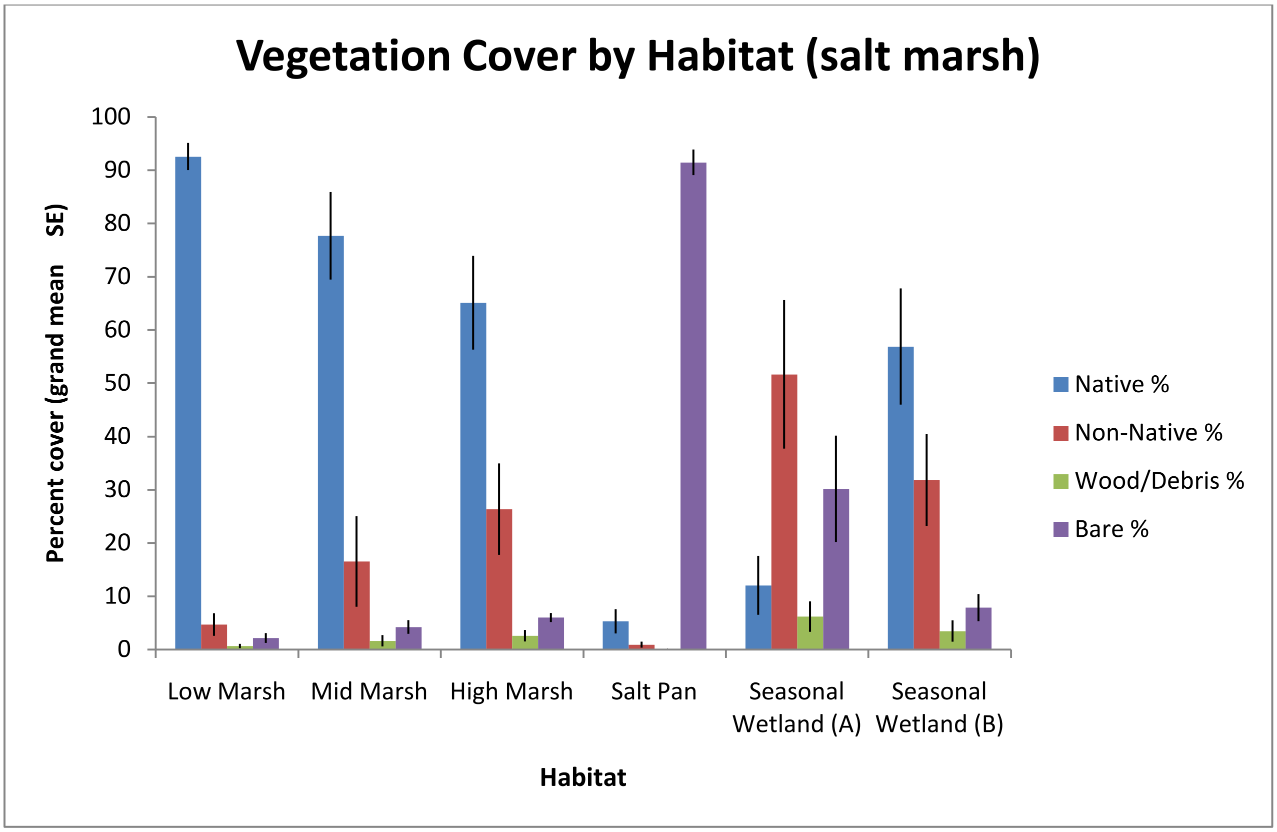

Figure 4.2. Vegetation percent cover (grand mean ± standard error) of native versus non-native species averaged for all transect across each salt marsh habitat type.

In the salt marsh habitats, the highest percent cover for individual plant species averaged across the whole habitat often included native species, such as *S. pacifica*, *Jaumea carnosa* (fleshy jaumea), *D. spicata, A. subterminale,* and *Cressa truxillensis* (spreading alkali weed) (Table 4.4); non-native grasses were also present in the high marsh and seasonal wetlands, especially in Area A. In some cases, a single vegetation species comprised nearly 10%, for example *C. truxillensis* (9.7%) and *Festuca perennis* (Italian rye grass) (9.4%) in the high marsh habitat. The seasonal wetland (A) habitat had many species of non-native grasses that did not individually account for 10%, for example *Brassica nigra* (common black mustard) (8.8%), *Bromus madritensis* (foxtail chess) (4.2%), and *Melilotus indicus* (sourclover) (2.8%), but that together represented a dominant group (15.8%). Most of the *J. carnosa* in the low marsh was covered by *Cuscuta salina* (saltmarsh dodder), a native parasitic plant that formed the top canopy layer in some instances. The salt pan habitat has very little vegetation, and was dominated by bare ground along all transects (92.2% overall bare ground cover; Table 4.4).

Table 4.4. Percent cover of dominant species (>10%) for each salt marsh habitat type. Non-native plant species are in red.

Species	Low Marsh	Mid Marsh	High Marsh	Salt Pan	Seasonal Wetland (A)	Seasonal Wetland (B)
Salicornia pacifica	63.8	39.2	29.6	----	12.0	41.9
Arthrocnemum subterminale	----	----	11.1	----	----	----
Cressa truxillensis	----	----	----	----	----	11.8
Distichlis spicata	----	14.6	11.0	----	----	----
Jaumea carnosa	14.5	17.4	----	----	----	----
Polypogon monspeliensis	----	----	----	----	----	10.2
Dead unknown grass	----	----	----	----	28.5	----
Festuca perennis	----	----	----	----	----	10.6
Bare ground	----	----	----	92.2	----	10.2

Non-Salt Marsh Habitat Results

Results are presented as grand means across the habitat ± standard error (SE). Non-salt marsh habitats evaluated included brackish and freshwater marshes, dunes, and upland scrub and grasslands. The marsh habitats (brackish and freshwater) had a higher average percent cover of native species (66.6 ± 8.5% and 60.5 ± 11.8%, respectively) than non-native species (Figure 4.3); the brackish marsh habitat had the highest average native percent cover of the non-salt marsh habitats evaluated. The dune and upland (grassland and scrub) habitats had a higher non-native species average percent cover (45.9 ± 6.9%, 73.5 ± 5.1%, and 65.5 ± 5.3%, respectively) than native (Figure 4.3). The upland grassland habitat type had the lowest average native plant species percent cover, at 3.5 ± 2.7% and the highest non-native plant species percent cover at 73.5 ± 5.1%.

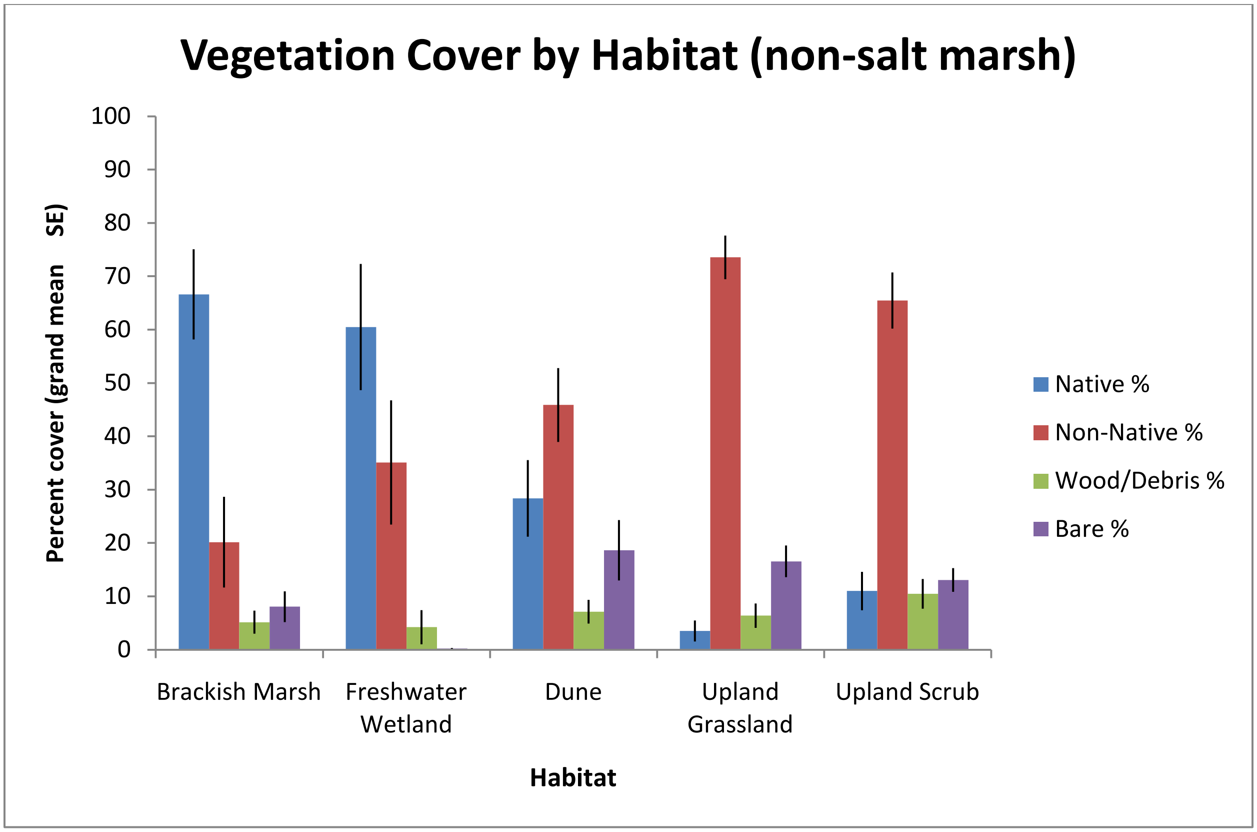

Figure 4.3. Vegetation percent cover (grand mean ± standard error) of native versus non-native plant species for all transects across each non-salt marsh habitat.

The brackish marsh habitat type was dominated by native *Schoenoplectus* spp. (Table 4.5). The freshwater marsh habitat of the southwestern portion of Area B was the only other non-salt marsh habitat type sampled that had a higher percentage of native versus non-native plant species and was dominated by the native plant species *Anemopsis californica* (yerba mansa) and *Juncus mexicanus* (Mexican wire rush) (Table 4.5). Note *J. mexicanus* was mislabeled in the first baseline year report as *Juncus balticus* (Baltic rush); *J. mexicanus* represents a dominant species both baseline years. The plant with the highest average percent cover in the freshwater marsh was the non-native *C. edulis*. The grassland habitat type had several non-natives that averaged greater than 10% cover: *B. nigra*, *Glebionis coronaria* (crown daisy), and dead non-native grasses (Table 4.5).

Similarly to the salt marsh habitats, several of the non-salt marsh habitats had individual species that were not dominant (>10% cover), but that were still present in considerable amounts along most transects. For example, in the dune habitat *Lupinus chamissonis* (fragrant dune lupine), *Lotus scoparius* (common deerweed), *D. spicata*, and *Croton californicus* (California croton) were all present at approximately 5% average cover. In the grassland, *Bromus diandrus* (ripgut brome), *Avena* sp., and *C. edulis* were all approximately 5%. In the scrub habitat, dead unknown grass was 8.9%.

Table 4.5. Percent cover of dominant species (>10% cover) for each non-salt marsh habitat. Note: non-native plant species are highlighted in red.

Species	Brackish Marsh	Freshwater Wetland	Dune	Upland Grassland	Upland Scrub
Anemopsis californica	----	30.0	----	----	----
Brassica nigra	----	----	----	20.6	17.6
Carprobrotus edulis	----	32.6	16.7	----	18.6
Glebionis coronaria	----	----	----	13.0	13.6
Erodium sp.	----	----	11.2	----	----
Juncus mexicanus	----	12.4	----	----	----
Schoenoplectus spp.	25.6	----	----	----	----
Dead non-native grasses	----	----	----	12.5	----
Wood / non-vegetated branches	----	----	----	----	10.5
Bare Ground	----	----	19.9	17.9	14.3

Baseline Vegetation Cover Results across both Years

Figures 4.4 and 4.5 display trends in habitat-level vegetation nativity across both baseline years. Overall, the pattern of percent cover of native species and non-native species in each habitat was similar between both baseline years. In both years the upland habitats were dominated by non-native species, and the salt marsh habitats were dominated by native species. The overall cover (native + non-native) was similar across both baseline years as well (e.g. salt pan had low cover).

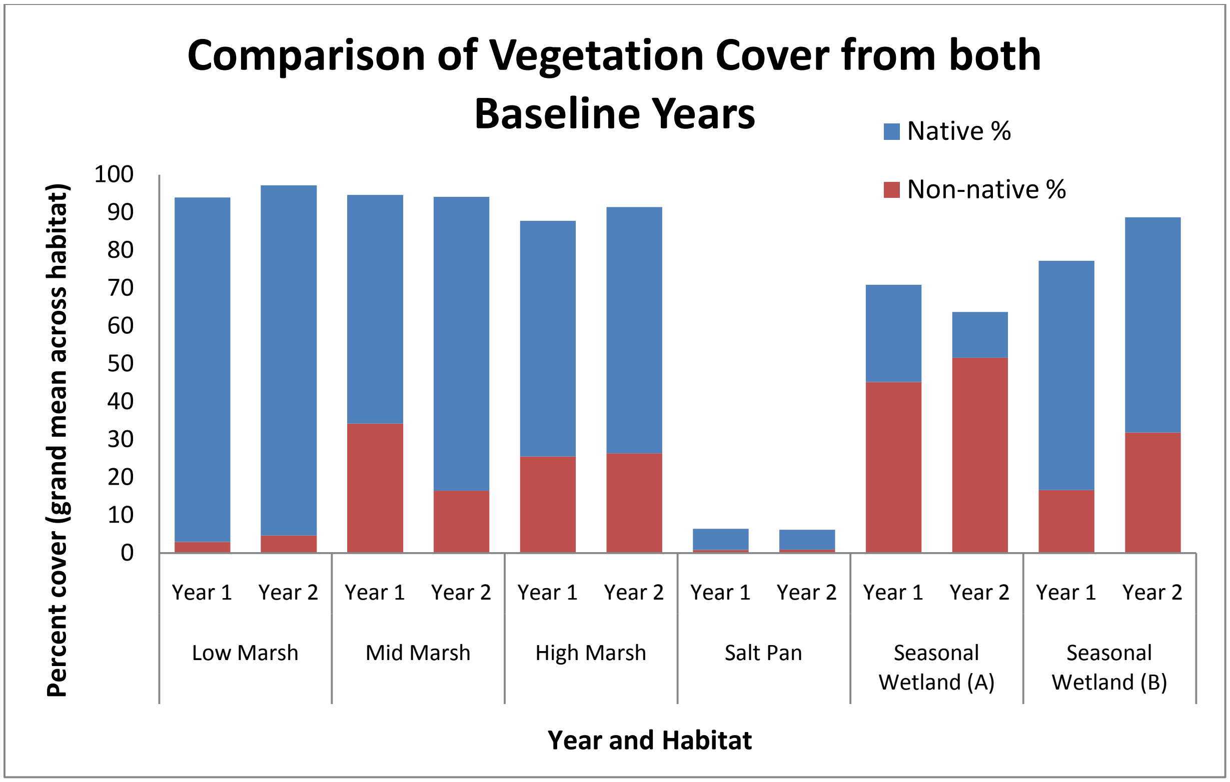

Figure 4.4. Vegetation percent cover comparison for both baseline years in the salt marsh habitats.

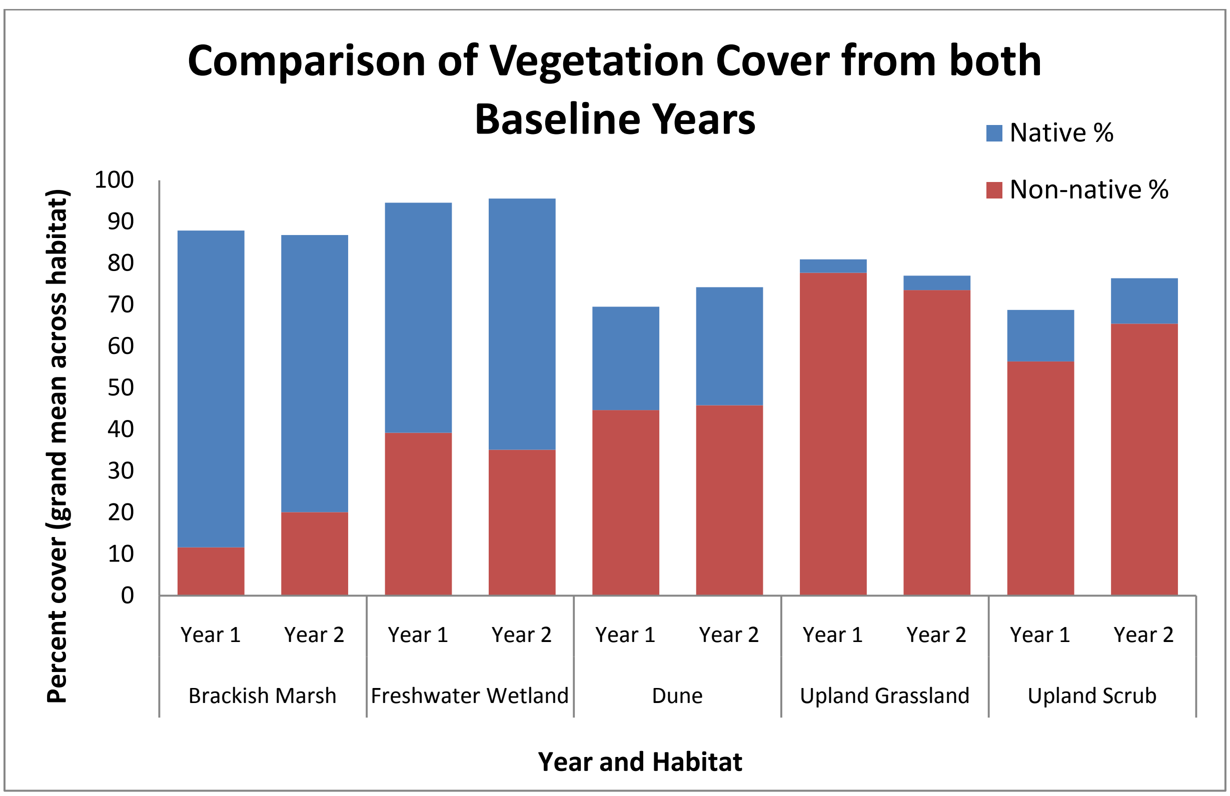

Figure 4.5. Vegetation percent cover comparison for both baseline years in the non-salt marsh habitats.

Seed Bank Survey Results

A total of 160 soil cores were collected from 16 salt marsh transects (i.e. 12 vegetation transects and four channel bank wrack transects). None of the blanks (controls) germinated any seeds. Two categories [i.e. "Unknown (Asteraceae)" and "Unknown (did not flower)"] were created for germinated seedlings that died before they were identifiable, never grew into adult plants, or never flowered.

Overall, 635 seedlings were identified from 120 cores taken from the vegetation transects and 269 seedlings from 40 cores taken from the channel bank transects (Table 4.6). Fifty-six soil cores never germinated any seeds. Nineteen plant species germinated in the soil cores (Table 4.6); six were native species representing 45% of the total number of germinated seedlings on transects. *S. pacifica* represented 42% of the seedlings on the vegetation transects and 47% of the seedlings on the channel bank transects. Non-native grasses accounted for 40% of germinated seedlings along the vegetation transects and 10% of the channel bank germinated seedlings. Table 4.6 lists all species germinated from both the vegetation transects and the channel bank transects.

The most common species on the vegetation transects included the native plant *S. pacifica*. The most common non-native plant species included *F. perennis*, *P. monspeliensis* (rabbit's foot grass), *M. indicus*, and *B. madritensis* (Table 4.6). More than 10 seedlings of each of these species germinated.

Table 4.6. All species and total number of germinated seedlings from seed bank transects. Non-native plant species are highlighted in red.

Scientific Name	Common Name	Transect total	Channel bank total
Atriplex sp.	atriplex	4	1
Bromus carinatus	California brome	3	2
Bromus madritensis	foxtail chess	8	4
Bromus sp.	brome	4	0
Cressa truxillensis	alkali weed	10	4
Distichlis spicata	saltgrass	0	12
Erigeron canadensis	Canadian horseweed	1	0
Festuca perennis	Italian ryegrass	128	20
Hordeum sp.	barley	2	0
Jaumea carnosa	fleshy jaumea	0	65
Juncus bufonius	common toad rush	2	0
Melilotus indicus	sour clover	66	23
Mesembryanthemum nodiflorum	slender leaf ice plant	1	0
Parapholis incurva	sickle grass	5	4
Polypogon monspeliensis	rabbit foot grass	106	0
Salicornia pacifica	pickleweed	264	126
Spergularia sp.	sand - spurrey	7	1
Unknown (Asteraceae)	----	13	3
Unknown (did not flower)	----	11	4
TOTAL # SEEDLINGS	----	**635**	**269**
# TRANSECTS	----	**12**	**4**
# SEEDLINGS PER TRANSECT	----	**52.92**	**67.25**

The seasonal wetland (B) habitat type had the highest average number of native germinated seedlings / m² (Figure 4.6); the salt pan and seasonal wetland (A) habitat types had the lowest average numbers of native germinated seedlings / m²; although in the case of the salt pan, is was due to the fact that only one seedling germinated out of all of the salt pan cores. The high marsh habitat type had the highest average number of non-native germinated seedlings / m² (Figure 4.6).

The channel bank transects and the salt pan transects had the lowest average number of non-native germinated seedlings / m². Of the individual channel bank transects, Channel-1 had the highest number of seedlings / m², and Channel-4 (the salt pan transect) had the least number of seedlings / m².

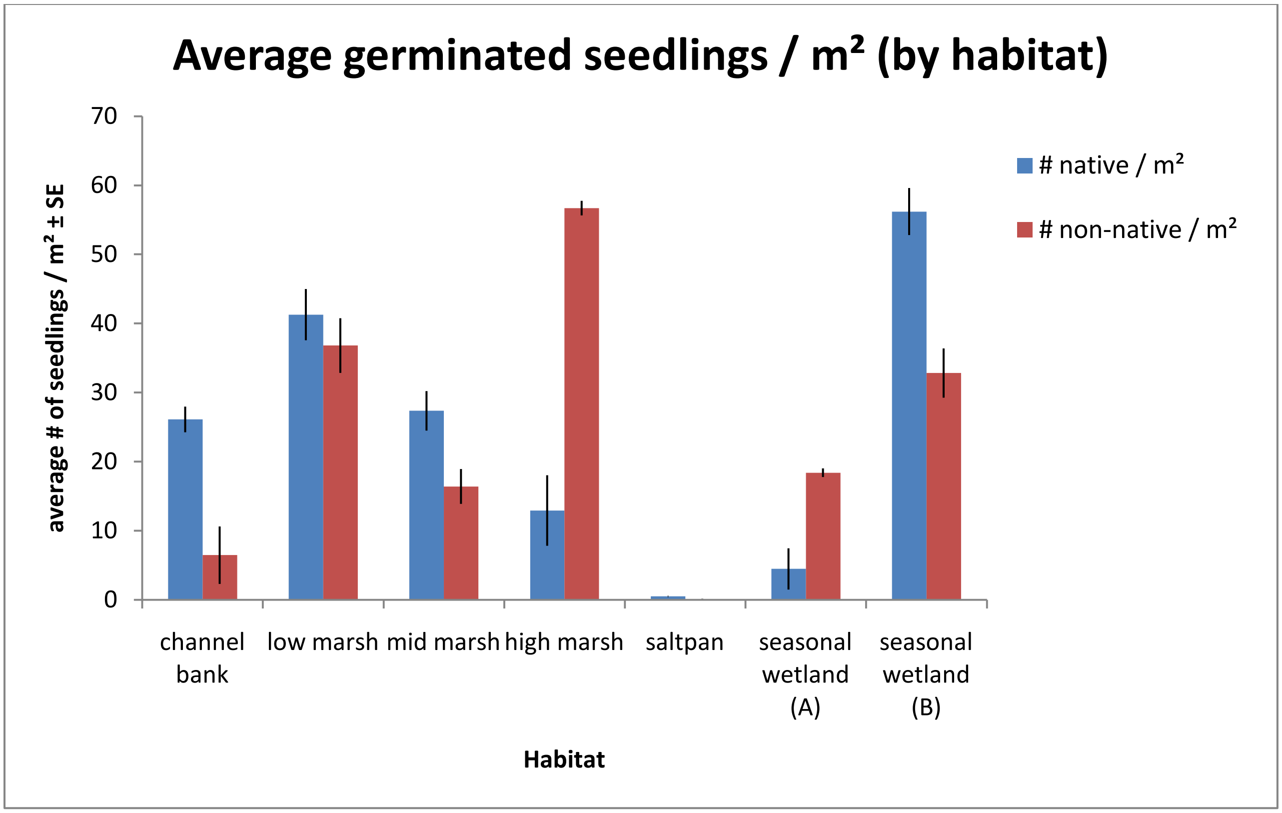

Figure 4.6. Number of germinated seedlings (± SE) averaged across each habitat.

Algae Cover Results

Transects were analyzed to determine if there was a seasonal or a transect-level effect. The September surveys had the highest percent cover of *Ulva intestinalis* (algae) (Figure 4.7). The June surveys had the highest percent cover of *Ulva lactuca.* January had the lowest algal cover of all months surveyed.

When averaged across all months, transect 2 had the highest overall percent cover of algae at 43.3% and the highest cover of *U. intestinalis* at 37.3% (Figure 4.8). Transect 4 had the highest percent cover of both *U. lactuca* at 21.2% and trash at 6.5%. *Ruppia maritima* was observed within the tidal channels, though it was not identified on any transects.

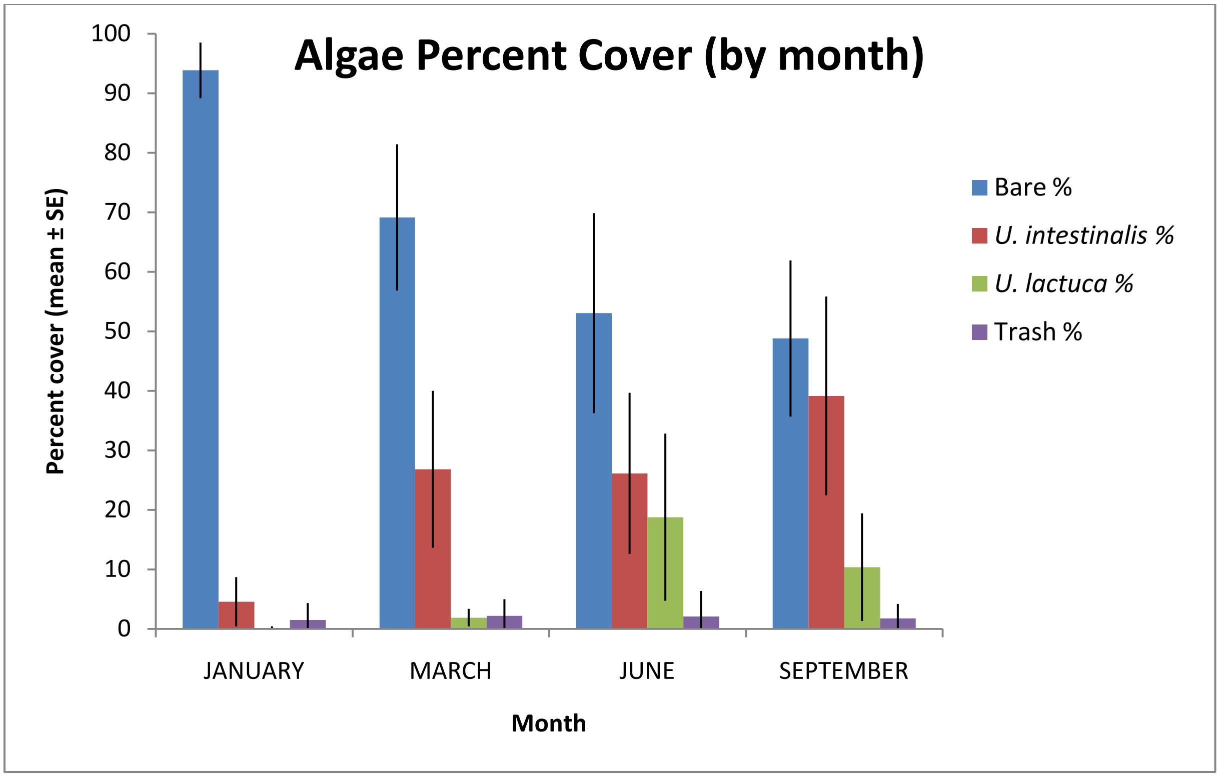

Figure 4.7. Average percent cover of algae/SAV (± SE) by month.

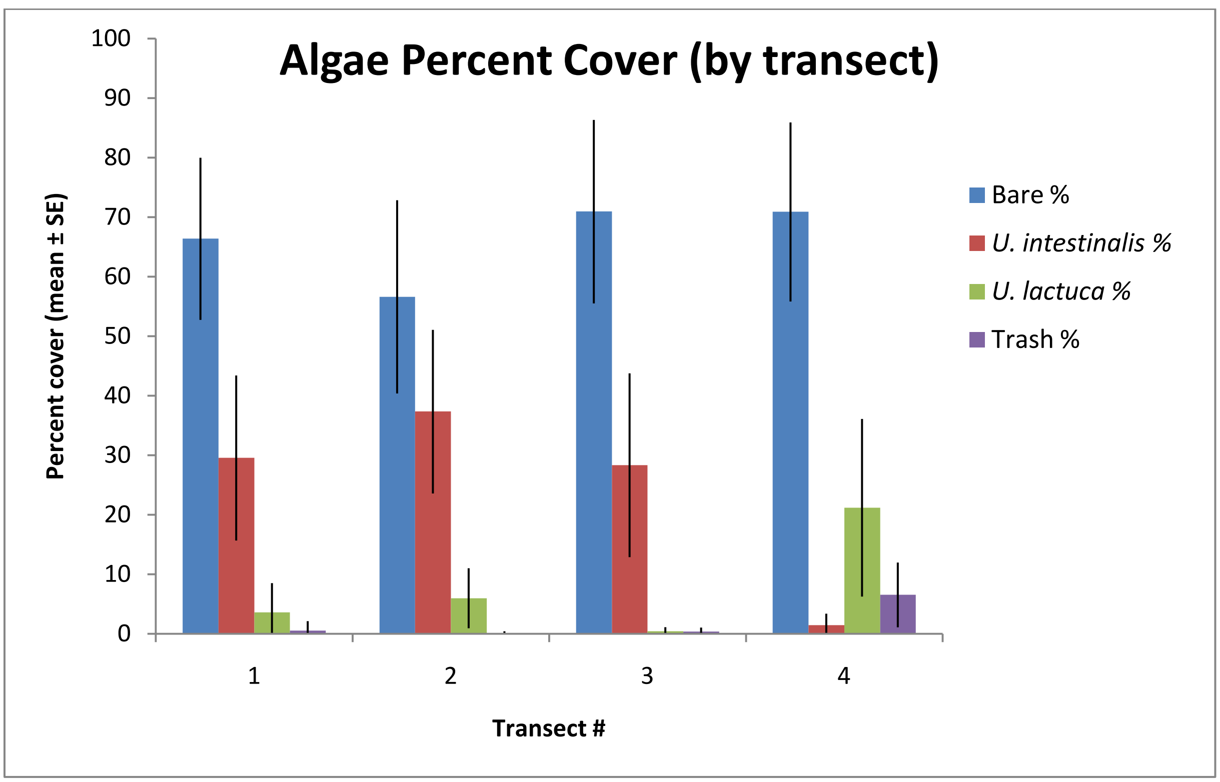

Figure 4.8. Average percent cover of algae/SAV (± SE) by transect.

Figure 4.9 compares percent cover between months surveyed in both baseline years (i.e. March, June, and September). January was excluded from the analysis as there were no January data in the first baseline year. Percent cover was averaged across all transects for each month. There was more bare ground in March of the second baseline year, and more bare ground in June and September during the first baseline year. The highest average percent cover of *U. lactuca* was in June of the second baseline year. The second baseline year also saw a higher percentage of trash cover in all months surveyed.

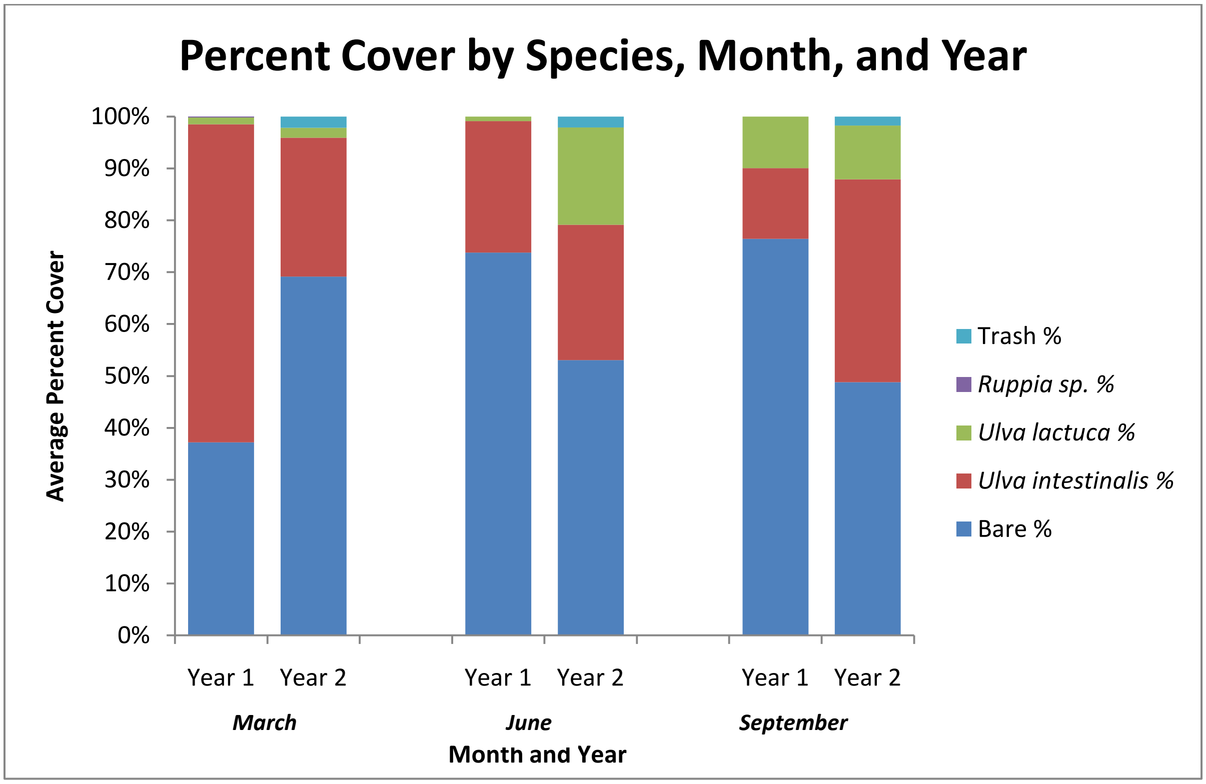

Figure 4.9. Graph of average percent cover by year, month, and species.

Special Status Species

No special status plant species were observed within 10 m of any vegetation transect. A separate targeted survey program was implemented for all listed plant species of special concern (federal, state, and CDFG; Appendix C.2) that may occur within the BWER. The results from special status species plant surveys will be available as separate reports on the BWER website (www.ballonarestoration.org).

ANALYSIS OF BASELINE RESULTS

When evaluating both years of baseline data together, several patterns emerge. The first is that the overall averages of vegetative cover nativity and dominant species within each habitat remained the same across both baseline years, even though different quadrats were evaluated within the transects (transects were fixed and quadrats were random). This provides a clear assessment of the dominant species by habitat type, which further allows an identification of which habitat types are more prone to non-native species (e.g. upland grassland and portions of the dune and seasonal wetland A habitats).

The dominant species tables also identify which habitats tend to have one or only a couple of dominant species (e.g. low marsh) and which habitats have several more co-dominant species (e.g. upland scrub), even if many of them are non-native. The overall cover of the dominant species tended to remain very similar across both baseline years for some species [e.g. *S. pacifica, Artemisia californica* (California sage brush)] and slightly more variable for other, more annual species (e.g. *G. coronaria, B. nigra*). This is often variable based on abiotic conditions such as rainfall during a particular year, especially for annual species, and is why some habitats (e.g. grassland) may be more important to monitor more frequently. The low degree of inter-annual variability in some of the habitats (e.g. low marsh and salt pan) may justify a reduction in sampling frequency, or a reduction in the overall number of transects. Further statistical analyses will better assess the data for this purpose.

Additional analyses should be performed on individual transect data. Some had higher variability and explained much of the error in the average plant nativity for a particular habitat. A third year of monitoring will allow better tracking of temporal variability, and provide additional individual transect points and species cover information. These data may be interpreted with additional metrics of higher ecosystem level function to provide additional insight into variability between (or within) habitats (e.g. plant biomass).

Seed Bank Analysis

The seed bank data from the vegetation transects were highly variable across the two baseline years. The channel bank transect data exhibited the opposite results; they were very similar across both baseline years. Some of the variability in the vegetation transect data can be explained by the low number of transects averaged for each habitat each year (i.e. three transects per habitat in the first baseline year, and two transects per habitat in the second baseline year). Additional variability can be explained by a shift of transect locations within a particular habitat. For example, the randomly chosen mid marsh year two transects were located further from channel banks in areas with more berm and high marsh vegetation (e.g. non-native grasses). Seasonal wetland (A) habitat consistently (across both baseline years) had low germination rates. Seasonal wetland (B) was highly variable and should have additional transects assessed in the next monitoring year. High marsh was dominated by non-natives both years.

FUTURE DIRECTIONS

Cover surveys will continue every two to three years to determine temporal trends. Algal and seed bank surveys will continue annually using the same methods described in this report. Plant tissue and biomass samples will be collected on a subset of the vegetation transects once every five years and three transects will be sampled in each habitat type. Pending funding availability, plant tissue will be collected on each of these transects from the three most common plants in the habitat to test for constituents of concern.

APPENDIX C.1

Plant species identified within 10 meters of permanent vegetation transects at the Ballona Wetlands Ecological Reserve during the first and second year of the Baseline Assessment Program

Family	Scientific Name	Common Name	Saltmarsh		Other Marsh		Upland	
			Year 1	Year 2	Year 1	Year 2	Year 1	Year 2
Arecaceae	----	palm tree			X	X	X	X
Fabaceae	*Acacia sp.*	acacia	X	X			X	X
Asteraceae	*Acroptilon repens**	Russian knapweed		X				X
Asteraceae	*Ambrosia chamissonis*	Chamisso's ragweed					X	X
Asteraceae	*Ambrosia psilostachya*	western ragweed			X	X	X	X
Primulaceae	*Anagallis arvensis**	scarlet pimpernel					X	X
Saururaceae	*Anemopsis californica*	yerba mansa			X	X		X
Apiaceae	*Apium graveolens**	common celery						X
Asteraceae	*Artemisia californica*	California sage brush					X	X
Asteraceae	*Artemisia sp.*	mugwort						X
Chenopodiaceae	*Arthrocnemum subterminale*	Parish's pickleweed	X	X				
Poaceae	*Arundo donax**	giant cane					X	X
Chenopodiaceae	*Atriplex lentiformis*	saltbrush			X		X	X
Chenopodiaceae	*Atriplex semibaccata**	Australian saltbush	X	X			X	
Chenopodiaceae	*Atriplex sp.*	atriplex		X				
Chenopodiaceae	*Atriplex prostrata**	spear oracle		X	X	X	X	X
Poaceae	*Avena fatua**	wild oat		X	X		X	X
Poaceae	*Avena sp.*	oat						X
Asteraceae	*Baccharis pilularis*	coyote brush		X	X		X	X
Asteraceae	*Baccharis salicifolia*	mule fat			X	X	X	X
Chenopodiaceae	*Bassia hyssopifolia*	five-hook bassia	X	X		X	X	X
Brassicaceae	*Brassica nigra**	common black mustard	X	X	X	X	X	X
Brassicaceae	*Brassica rapa**	common yellow mustard						X
Brassicaceae	*Brassica spp.*	mustard						X
Poaceae	*Bromus carinatus*	brome grass		X		X	X	X
Poaceae	*Bromus diandrus**	ripgut chess	X	X	X	X	X	X
Poaceae	*Bromus madritensis**	foxtail chess		X			X	X
Poaceae	*Bromus spp.*	brome grass		X				X
Onagraceae	*Camissoniopsis spp.*	sun cup					X	X
Aizoaceae	*Carpobrotus edulis**	hottentot fig	X	X	X	X	X	X
Asteraceae	*Centaurea melitensis**	tocalote					X	X
Euphorbiaceae	*Chamaesyce sp.*	chamaesyce					X	X

Family	Scientific Name	Common Name	Saltmarsh		Other Marsh		Upland	
			Year 1	Year 2	Year 1	Year 2	Year 1	Year 2
Poaceae	*Cortaderia selloana**	pampas grass	X	X	X	X	X	X
Convolvulaceae	*Cressa truxillensis*	spreading alkali weed	X	X	X	X	X	X
Euphorbiaceae	*Croton californicus*	California croton					X	X
Cuscutaceae	*Cuscuta salina*	saltmarsh dodder	X	X				
Poaceae	*Distichlis spicata*	saltgrass	X	X	X	X	X	X
Poaceae	*Elymus triticoides*	creeping wild ryegrass		X		X		
Asteraceae	*Encelia californica*	California bush sunflower						X
Asteraceae	*Ericameria ericoides*	California goldenbush					X	X
Asteraceae	*Erigeron canadensis*	Canadian horseweed		X	X	X	X	X
Polygonaceae	*Eriogonum parvifolium*	dune buckwheat			X			X
Geraniaceae	*Erodium spp.*	filaree					X	X
Myrtaceae	*Eucalyptus sp.*	gum tree			X	X		X
Euphorbiaceae	*Euphorbia terracina**	terracina spurge			X		X	X
Asteraceae	*Euthamia occidentalis*	western goldenrod			X	X		X
Poaceae	*Festuca perennis**	Italian rye-grass		X	X	X	X	X
Apiaceae	*Foeniculum vulgare**	common fennel			X	X		X
Frankeniaceae	*Frankenia salina*	alkali heath	X	X	X	X	X	X
Asteraceae	*Glebionis coronaria**	crown daisy		X			X	X
Boraginaceae	*Heliotropium curassavicum*	salt heliotrope			X	X	X	X
Asteraceae	*Heterotheca grandiflora*	telegraph weed			X	X	X	X
Poaceae	*Hordeum depressum*	dwarf barley		X			X	
Poaceae	*Hordeum murinum ssp. leporinum**	wild barley		X			X	X
Asteraceae	*Jaumea carnosa*	fleshy jaumea	X	X			X	X
Juncaceae	*Juncus mexicanus*	Mexican wire rush			X	X		
Juncaceae	*Juncus sp.*	rush wire grass			X	X		
Asteraceae	*Lactuca serriola**	common prickly lettuce					X	
Fabaceae	*Lotus scoparius*	common deerweed			X	X	X	X
Fabaceae	*Lupinus chamissonis*	fragrant dune lupine			X	X	X	X
Malvaceae	*Malva parviflora**	cheeseweed mallow					X	
Malvaceae	*Malvella leprosa*	alkali mallow		X	X	X	X	X
Lamiaceae	*Marrubium vulgare**	horehound					X	X
Fabaceae	*Medicago lupulina**	black medicago					X	
Fabaceae	*Medicago polymorpha**	toothed burclover					X	
Myrtaceae	*Melaleuca citrina**	crimson bottlebrush						X

Family	Scientific Name	Common Name	Saltmarsh		Other Marsh		Upland	
			Year 1	Year 2	Year 1	Year 2	Year 1	Year 2
Myrtaceae	*Melaleuca sp.*	melaleuca				X		
Fabaceae	*Melilotus indicus**	sourclover		X	X	X	X	X
Aizoaceae	*Mesembryanthemum crystallinum**	crystalline iceplant			X			
Aizoaceae	*Mesembryanthemum nodiflorum**	slenderleaf iceplant	X	X			X	X
Myoporaceae	*Myoporum laetum**	lollypop tree	X	X			X	X
Solanaceae	*Nicotiana glauca**	tree tobacco					X	X
Poaceae	*Parapholis incurva**	sicklegrass		X			X	
Hydrophyllaceae	*Phacelia ramosissima*	branching phacelia			X	X	X	X
Poaceae	*Phalaris aquatica**	canary grass		X				
Plantaginaceae	*Plantago sp.*	rib grass						X
Poaceae	*Polypogon monspeliensis**	rabbit's foot grass		X	X	X	X	X
Asteraceae	*Pseudognaphalium spp.*	false cudweed		X		X	X	X
Brassicaceae	*Raphanus sativus**	wild radish		X	X	X	X	X
Euphorbiaceae	*Ricinus communis**	castor bean			X	X	X	X
Polygonaceae	*Rumex crispus**	curly dock		X	X	X	X	X
Polygonaceae	*Rumex sp.*	dock		X			X	X
Chenopodiaceae	*Salicornia pacifica*	common pickleweed	X	X	X	X	X	X
Salicaceae	*Salix lasiolepis*	arroyo willow					X	
Salicaceae	*Salix sp.*	willow				X	X	X
Chenopodiaceae	*Salsola sp.*	Russian-thistle		X				
Anacardiaceae	*Schinus terebinthifolius**	Brazilian pepper tree			X	X	X	X
Cyperaceae	*Scirpus spp.*	bulrush			X	X	X	X
Asteraceae	*Silybum marianum**	blessed milk thistle		X				X
Asteraceae	*Sonchus spp.*	sow thistle			X	X	X	X
Juncaginaceae	*Tropaeolum majus**	nasturtium						X
Typhaceae	*Typha sp.*	cat tail				X		
Asteraceae	*Xanthium strumarium*	common cocklebur				X		X
Agavaceae	*Yucca sp.*	yucca						X
	Number of species		16	41	40	42	64	75

Note: 'Saltmarsh' category includes low, mid, and high estuarine marsh habitat types. 'Other marsh' category includes all seasonal, brackish, and freshwater wetland habitat types. 'Upland' category includes all upland scrub, dune, and grassland habitat types.

Asterisks denote non-native species, not including those categories only identified to genus.

APPENDIX C.2

Special status plant species that ***may*** occur, or are known to occur in habitats similar to those found in the Ballona Wetlands Ecological Reserve. Note: List compiled from the U.S. Fish and Wildlife Service (USFWS) Species Lists (September 2010), California Native Plant Society (CNPS) Electronic Inventory (September 2010) and California Natural Diversity Database (CNDDB) (September 2010) searches of the Venice, Redondo Beach, Beverly Hills, and Topanga USGS 7.5 minute quadrangles. Appendix reproduced from WRA 2011.

SPECIES	STATUS*	HABITAT REQUIREMENTS	POTENTIAL TO OCCUR IN PROJECT AREA	RESULTS AND RECOMMENDATIONS
Red sand verbena *Abronia maritima*	List 4	Coastal dunes. Elevation range: 0 – 325 feet. Blooms: February – November.	**Moderate Potential.** The Reserve contains restored coastal dune habitat that may support this species.	**Not Observed.** Focused rare plant survey in October did not observe this species in the Reserve.
Aphanisma *Aphanisma blitoides*	List 1B	Coastal bluff scrub, coastal dunes, coastal scrub. Typically located on bluffs and slopes near the ocean on sandy or clay soils. Elevation range: 1 – 990 feet. Blooms: March – June.	**Unlikely.** Although the Reserve contains restored coastal dune and coastal scrub habitat, this species is known primarily from the Channel Islands and drier, steeper bluff sites not present in the Reserve.	No further actions are recommended for this species.
Marsh sandwort *Arenaria paludicola*	FE, SE, List 1B	Marshes and swamps. Typically located in dense mats of emergent marsh vegetation. Elevation range: 485 – 3965 feet. Blooms: May – August.	**Unlikely.** Although the Reserve contains coastal salt marsh habitat, this species is closely associated with freshwater wetland habitat.	No further actions are recommended for this species.
Braunton's milk-vetch *Astragalus brauntonii*	FE, List 1B	Closed-cone coniferous forest, chaparral, coastal scrub, valley and foothill grassland. Often in recent burns or disturbed areas on gravelly clay soils overlying granite or limestone. Elevation range: 10 – 2075 feet. Blooms: January – August.	**Unlikely.** Although the Reserve contains coastal scrub habitat, this species is known from more inland sites.	No further actions are recommended for this species.
Ventura milk-vetch *Astragalus pycnostachyus* var. *lanosissimus*	FE, SE, List 1B	Coastal salt marsh, coastal dune, coastal scrub. Typically located within reach of high tide protected by barrier beaches and near seeps on sandy bluffs. Elevation range: 1 – 115 feet. Blooms: June – October.	**Moderate Potential.** The Reserve contains coastal salt marsh, restored coastal dune, and coastal scrub habitat that may support this species. Nearest known occurrence is less than 1.5 miles to the north.	**Not Observed.** Focused rare plant surveys in July and October did not observe this species in the Reserve.
Coastal dunes milk-vetch *Astragalus tener* var. *titi*	FE, SE, List 1B	Coastal bluff scrub, coastal dunes. Located on moist, sandy depressions of bluffs and dunes along or near the ocean. Elevation range: 1 – 165 feet. Blooms: March – May.	**Moderate Potential.** The Reserve contains restored coastal dune habitat that may support this species.	**Not Observed.** Focused rare plant surveys in April did not observe this species in the Reserve.
South Coast saltscale *Atriplex pacifica*	List 1B	Coastal scrub, coastal bluff scrub, playas, chenopod scrub. Located on alkali soils. Elevation range: 0 – 460 feet. Blooms: March – October.	**Moderate Potential.** The Reserve contains coastal scrub habitat that may support this species.	**Not Observed.** Focused rare plant surveys in April, July, and October did not observe this species in the Reserve.

APPENDIX C.2

SPECIES	STATUS*	HABITAT REQUIREMENTS	POTENTIAL TO OCCUR IN PROJECT AREA	RESULTS AND RECOMMENDATIONS
Parish's brittlescale *Atriplex parishii*	List 1B	Alkali meadows, vernal pools, chenopod scrub, playas. Typically located on alkali flats with finely textured soils. Elevation range: 80 – 6160 feet. Blooms: June – October.	**Moderate Potential.** The Reserve contains playa-like and alkali meadow habitat that may support this species.	**Not Observed.** Focused rare plant surveys in July and October did not observe this species in the Reserve.
Davidson's saltscale *Atriplex serenana* var. *davidsonii*	List 1B	Coastal bluff scrub, coastal scrub. Located on alkaline soils. Elevation range: 30 – 650 feet. Blooms: April – October.	**Moderate Potential.** The Reserve contains coastal scrub habitat underlain by alkaline substrate that may support this species.	**Not Observed.** Focused rare plant survey in October did not observe this species in the Reserve.
Brewer's red maids *Calandrinia breweri*	List 4	Chaparral, coastal scrub. Located on sandy or loamy soils, often in disturbed areas. Elevation range: 30 – 3695 feet. Blooms: March – June.	**Unlikely.** Although the Reserve contains coastal scrub habitat, this species is known from more inland sites at higher elevations.	No further actions are recommended for this species.
Seaside red maids *Calandrinia maritima*	List 4	Coastal bluff scrub, coastal scrub, valley and foothill grassland. Elevation range: 15 – 975 feet. Blooms: sometimes February, March – June, sometimes August.	**Unlikely.** Although the Reserve contains coastal scrub habitat, this species is known from the Channel Islands.	No further actions are recommended for this species.
Plummer's mariposa-lily *Calochortus plummerae*	List 1B	Coastal scrub, chaparral, valley and foothill grassland, cismontane woodland, lower montane coniferous forest. Located on rocky and sandy sites derived from granitic or alluvial material; often occurs following fires. Elevation range: 320 – 5510 feet. Blooms: May – July.	**Unlikely.** Although the Reserve contains coastal scrub habitat, this species is known from sites with higher elevation and further inland.	No further actions are recommended for this species.
Santa Barbara morning-glory *Calystegia sepium* ssp. *binghamiae*	List 1A	Coastal marshes. Elevation range: 0 – 65 feet. Blooms: April – May.	**Moderate Potential.** The Reserve contains coastal salt marsh habitat that may support this species.	**Not Observed.** Focused rare plant survey in April did not observe this species in the Reserve.
Lewis' evening-primrose *Camissoniopsis lewisii* [*Camissonia lewisii*]	List 3	Coastal bluff scrub, cismontane woodland, coastal dunes, coastal scrub, valley and foothill grassland. Elevation range: 0 – 975 feet. Blooms: March – May, sometimes June.	**High Potential.** The Reserve contains restored coastal dune and coastal scrub habitat that may support this species. Known occurrence from previous studies suggest this species is present in the Reserve.	**Present.** Focused rare plant survey in April located this species in Areas A and C1.
Southern tarplant *Centromadia parryi* ssp. *australis*	List 1B	Marshes and swamps margins, valley and foothill grassland. Often located on disturbed sites near the coast on alkali soils. Elevation range: 0 – 1385 feet. Blooms: May – November.	**High Potential.** The Reserve contains coastal salt marsh habitat that may support this species. Known occurrence from previous studies suggest this species is present in the Reserve.	**Not Observed.** Focused rare plant survey in July did not observe this species in the Reserve.

APPENDIX C.2

SPECIES	STATUS*	HABITAT REQUIREMENTS	POTENTIAL TO OCCUR IN PROJECT AREA	RESULTS AND RECOMMENDATIONS
Orcutt's pincushion *Chaenactis glabriuscula* var. *orcuttiana*	List 1B	Coastal bluff scrub, coastal dunes. Located on sandy soils. Elevation range: 10 – 330 feet. Blooms: January – August.	**High Potential.** The Reserve contains restored coastal dune habitat that may support this species. Known occurrence from previous studies suggest this species is present in the Reserve.	**Present.** Focused rare plant survey in April located this species in Area B1.
Coastal goosefoot *Chenopodium littoreum*	List 1B	Coastal dunes. Located on sandy soils. Elevation range: 30 – 95 feet. Blooms: April – August.	**Moderate Potential**. The Reserve contains coastal dune habitat that may support this species.	**Not Observed.** Focused rare plant survey in April did not observe this species in the Reserve.
San Fernando Valley spineflower *Chorizanthe parryi* var. *fernandina*	FC, SE, List 1B	Coastal scrub. Located on sandy soils. Elevation range: 490 – 4000 feet. Blooms: April – July.	**Moderate Potential.** The Reserve contains coastal scrub habitat that may support this species. Known occurrence from Ballona Harbor less than 1 mile to the north.	**Not Observed.** Focused rare plant survey in July did not observe this species in the Reserve.
Small-flowered morning-glory *Convolvulus simulans*	List 4	Chaparral, coastal scrub, valley and foothill grassland. Located in openings on clay soils and serpentine seeps. Elevation range: 95 – 2275 feet. Blooms: March – July.	**Unlikely.** Although the Reserve contains coastal scrub habitat, this species is known from sites with higher elevation and further inland.	No further actions are recommended for this species.
Salt marsh bird's-beak *Cordylanthus maritimus* ssp. *maritimus*	FE, SE, List 1B	Coastal salt marsh, coastal dunes. Located on the higher zones of salt marshes. Elevation range: 0 – 100 feet. Blooms: May – October.	**Moderate Potential.** The Reserve contains coastal salt marsh habitat that may support this species.	**Not Observed.** Focused rare plant surveys in July and October did not observe this species in the Reserve.
Paniculate tarplant *Deinandra paniculata*	List 4	Coastal scrub, valley and foothill grassland, vernal pools. Typically located on vernally mesic sites. Elevation range: 80 – 3055 feet. Blooms: April – November.	**Moderate Potential.** The Reserve contains coastal scrub habitat that may support this species.	**Not Observed.** Focused rare plant surveys in July and October did not observe this species in the Reserve.
Western pony's-foot *Dichondra occidentalis*	List 4	Chaparral, cismontane woodland, valley and foothill grassland, coastal scrub. Elevation range: 160 – 1625 feet. Blooms: sometimes January, March – July.	**High Potential.** The Reserve contains coastal scrub habitat that may support this species. Reported occurrences from previous studies suggest this species is present in the Reserve (Existing Conditions citing Hendrickson 1991 EIR).	**Not Observed.** Focused rare plant surveys in April and July did not observe this species in the Reserve.

APPENDIX C.2

SPECIES	STATUS*	HABITAT REQUIREMENTS	POTENTIAL TO OCCUR IN PROJECT AREA	RESULTS AND RECOMMENDATIONS
Beach spectaclepod *Dithyrea maritima*	ST, List 1B	Coastal dunes, coastal scrub. Located at sea shores on sand dunes and sandy places near the shore. Elevation range: 10 – 165 feet. Blooms: March – May.	**Moderate Potential.** The Reserve contains restored coastal dune and coastal scrub habitat that may support this species. Additionally, the nearest known occurrence is from "vicinity of Ballona Marshes" (CNDDB 2010).	**Not Observed.** Focused rare plant survey in April did not observe this species in the Reserve.
Santa Monica dudleya *Dudleya cymosa* ssp. *ovatifolia*	FT, List 1B	Chaparral, coastal scrub. Located in canyons on sedimentary conglomerates on primarily north-facing slopes. Elevation range: 485 – 5430 feet. Blooms: March – June.	**Unlikely.** Although the Reserve contains coastal scrub habitat, this species is known from sites with higher elevation and further inland.	No further actions are recommended for this species.
Many-stemmed dudleya *Dudleya multicaulis*	List 1B	Chaparral, coastal scrub, valley and foothill grassland. Located on clay soils. Elevation range: 45 – 2560 feet. Blooms: April – July.	**Moderate Potential.** The Reserve contains coastal scrub habitat that may support this species.	**Not Observed.** Focused rare plant survey in July did not observe this species in the Reserve.
Island green dudleya *Dudleya virens* ssp. *insularis*	List 1B	Coastal bluff scrub, coastal scrub. Located on rocky sites. Elevation range: 15 – 975 feet. Blooms: April – June.	**Unlikely.** Although the Reserve contains coastal scrub habitat, this species typically is known from rocky, bluff sites in coastal scrub.	No further actions are recommended for this species.
Suffrutescent wallflower *Erysimum insulare* ssp. *suffrutescens*	List 4	Coastal bluff scrub, coastal scrub, valley and foothill grassland. Elevation range: 0 – 490 feet. Blooms: January – July.	**High Potential.** The Reserve contains coastal scrub habitat that may support this species. Known occurrence from previous studies suggest this species is present in the Reserve.	**Present.** Focused rare plant survey in July and April observed this species in the Area B1.
Los Angeles sunflower *Helianthus nuttallii* ssp. *parishii*	List 1A	Coastal salt and freshwater marshes and swamps. Elevation range: 30 – 5445 feet. Blooms: August – October.	**Moderate Potential.** The Reserve contains coastal salt marsh habitat that may support this species.	**Not Observed.** Focused rare plant survey in October did not observe this species in the Reserve.
Vernal barley *Hordeum intercedens*	List 3	Coastal dunes, coastal scrub, valley and foothill grassland, vernal pools. Located on saline flats and depressions. Elevation range: 15 – 3240 feet. Blooms: March – June.	**Moderate Potential.** The Reserve contains coastal scrub and restored coastal dune habitat that may support this species.	**Not Observed.** Focused rare plant survey in April did not observe this species in the Reserve.
Mesa horkelia *Horkelia cuneata* ssp. *puberula*	List 1B	Chaparral, cismontane woodland, coastal scrub. Elevation range: 225 – 2625 feet. Blooms: February – July, sometimes September.	**Unlikely.** Although the Reserve contains coastal scrub habitat, this species is known from sites with higher elevation and further inland.	No further actions are recommended for this species.

APPENDIX C.2

SPECIES	STATUS*	HABITAT REQUIREMENTS	POTENTIAL TO OCCUR IN PROJECT AREA	RESULTS AND RECOMMENDATIONS
Southwestern spiny rush *Juncus acutus* ssp. *leopoldii*	List 4	Coastal dunes, meadows and seeps, coastal salt marshes. Located on mesic, alkali sites. Elevation range: 10 – 2925 feet. Blooms: May – June.	**Moderate Potential.** The Reserve contains coastal salt marsh and restored coastal dune habitat that may support this species.	**Not Observed.** Focused rare plant survey in April did not observe this species in the Reserve.
Coulter's goldfields *Lasthenia glabrata* ssp. *coulteri*	List 1B	Coastal salt marshes, playas, valley and foothill grassland, vernal pools. Typically located on alkaline soils in playas, sinks, and grasslands. Elevation range: 1 – 3955 feet. Blooms: February – June.	**High Potential.** The Reserve contains coastal salt marsh habitat that may support this species. Although last observed in 1934, the nearest known occurrence of this species is known from "Ballona Marshes".	**Not Observed.** Focused rare plant survey in April did not observe this species in the Reserve.
California spineflower *Mucronea californica*	List 4	Chaparral, cismontane woodland, coastal dunes, coastal scrub, valley and foothill grassland. Located on sandy soils. Elevation range: 0 – 4550 feet. Blooms: March – July, sometimes August.	**Moderate Potential.** The Reserve contains restored coastal dune and coastal scrub habitat underlain by sandy substrate that may support this species.	**Not Observed.** Focused rare plant surveys in April and July did not observe this species in the Reserve.
Mud nama *Nama stenocarpum*	List 2	Marshes and swamps. Located on lake shores, streams banks, and intermittently wet areas. Elevation range: 15 – 1620 feet. Blooms: January – July.	**Moderate Potential.** The Reserve contains freshwater marsh margins that may support this species. Additionally, the nearest known occurrence of this species is from less than four miles to the north.	**Not Observed.** Focused rare plant survey in July did not observe this species in the Reserve.
Gambel's watercress *Nasturtium gambellii*	FE, ST, List 1B	Brackish and freshwater marshes and swamps. Located on lake and stream margins at or immediately above the water line. Elevation range: 15 – 1075 feet. Blooms: April – October.	**Unlikely.** Although the Reserve contains coastal salt marsh habitat, this species is known from freshwater and brackish marshes with lower salinity.	No further actions are recommended for this species.
Moran's nosegay *Navarretia fossalis*	FT, List 1B	Vernal pools, chenopod scrub, marshes and swamps, playas. Located on hardpan soils in swales, depressions, and pools. Elevation range: 95 – 4225 feet. April – June.	**Unlikely.** Although the Reserve contains marsh habitat, this species is known from more inland sites with lesser salinity and higher elevation.	No further actions are recommended for this species.
Prostrate vernal pool navarretia *Navarretia prostrata*	List 1B	Coastal scrub, valley and foothill grassland, vernal pools. Elevation range: 45 – 2270 feet. Blooms: April – July.	**Unlikely.** Although the Reserve contains coastal scrub, this species is requires freshwater vernal pool habitat not present in the Reserve.	No further actions are recommended for this species.
Coast woolly-heads *Nemacaulis denudata* var. *denudata*	List 1B	Coastal dunes. Elevation range: 0 – 325 feet. Blooms: April – September.	**Unlikely.** Although the Reserve contains restored dune habitat, this species is known only from south of Rancho Palos Verdes.	No further actions are recommended for this species.

APPENDIX C.2

SPECIES	STATUS*	HABITAT REQUIREMENTS	POTENTIAL TO OCCUR IN PROJECT AREA	RESULTS AND RECOMMENDATIONS
California Orcutt grass *Orcuttia californica*	FE, SE, List 1B	Vernal pools. Elevation range: 45 – 2145 feet. Blooms: April – August.	**No Potential.** The Reserve does not contain vernal pool habitat.	No further actions are recommended for this species.
Lyon's Pentachaeta *Pentachaeta lyonii*	FE, SE, List 1B	Chaparral, valley and foothill grassland. Located on the edge of openings at the ecotone between chaparral and grassland. Elevation range: 95 – 2050 feet. Blooms: March – August.	**No Potential.** The Reserve does not contain chaparral or intact grassland habitat.	No further actions are recommended for this species.
South Coast branching phacelia *Phacelia ramosissima* var. *austrolitoralis*	List 4	Chaparral, coastal dunes, coastal scrub, coastal salt marshes. Located on sandy, often rocky soils. Elevation range: 20 – 975 feet. Blooms: March – August.	**High Potential.** The Reserve contains restored coastal dune, coastal scrub, and coastal salt marsh habitat that may support this species. Additionally, the nearest documented occurrence is from within the Reserve.	Focused rare plant surveys in July, October, and April located this species; however, recent taxonomic descriptions do not recognize varieties (Jepson 2011).
Brand's star phacelia *Phacelia stellaris*	FC, List 1B	Coastal scrub, coastal dunes. Located in open areas. Elevation range: 1 – 1300 feet. Blooms: March – June.	**Moderate Potential.** The Reserve contains coastal scrub and coastal dune habitat that may support this species. Additionally, the nearest known occurrence of this species from less than one mile to the south.	**Not Observed.** Focused rare plant survey in April did not observe this species in the Reserve.
Ballona cinquefoil *Potentilla multijuga*	List 1A	Brackish meadows and seeps. Elevation range: 0 – 10 feet. Blooms: June – August.	**Moderate Potential.** The Reserve contains brackish grassland sites. The Reserve is the type locality of this species; however, it is presumed extinct.	**Not Observed.** Focused rare plant survey in July did not observe this species in the Reserve.
White rabbit-tobacco *Pseudognaphalium leucocephalum*	List 2	Riparian woodland, cismontane woodland, coastal scrub, chaparral. Elevation range: 0 – 6825 feet. Blooms: sometimes July, August – November, sometimes December.	**Unlikely.** Although the Reserve contains coastal scrub habitat, this species is known primarily from sites further inland.	No further actions are recommended for this species.
Salt Spring checkerbloom *Sidalcea neomexicana*	List 2	Alkali playas, brackish marshes, chaparral, coastal scrub, lower montane coniferous forest, Mojavean Desert scrub. Located on alkali springs and marshes. Elevation range: 45 – 4960 feet. Blooms: March – June.	**Moderate Potential.** The Reserve contains brackish marsh and coastal scrub habitat that may support this species.	**Not Observed.** Focused rare plant surveys in April did not observe this species in the Reserve.

APPENDIX C.2

SPECIES	STATUS*	HABITAT REQUIREMENTS	POTENTIAL TO OCCUR IN PROJECT AREA	RESULTS AND RECOMMENDATIONS
Estuary seablite *Suaeda esteroa*	List 1B	Coastal salt marshes. Located on clay, silt, and sand substrates. Elevation range: 0 – 15 feet. Blooms: May – October.	**High Potential.** The Reserve contains coastal salt marsh habitat. Reported occurrences from previous studies suggest this species is present in the Reserve (Existing Conditions citing Hendrickson 1991 EIR).	**Not Observed.** Focused rare plant surveys in July and October did not observe this species in the Reserve.
Woolly seablite *Suaeda taxifolia*	List 4	Coastal bluff scrub, coastal dunes, margins of coastal salt marshes. Elevation range: 0 – 165 feet. Blooms: January – December.	**High Potential.** The Reserve contains coastal salt marsh and coastal dune habitat. Known occurrences from previous studies suggest this species is present in the Reserve.	**Present.** Focused rare plant surveys in April, July, and October located this species in Area B1.
San Bernardino aster *Symphyotrichum defoliatum*	List 1B	Meadows and seeps, marshes and swamps, coastal scrub, cismontane woodland, lower montane coniferous forest, grassland. Located in mesic grassland near ditches, streams, and springs. Elevation range: 5 – 6630 feet. Blooms: July – November.	**Unlikely.** Although the Reserve contains coastal scrub habitat, this species is known from sites further inland.	No further actions are recommended for this species.
Greata's aster *Symphyotrichum greatae*	List 1B	Chaparral, cismontane woodland. Located in mesic canyons. Elevation range: 975 – 6535 feet. Blooms: June – October.	**No Potential.** The Reserve does not contain chaparral or woodland habitat to support this species.	No further actions are recommended for this species.

*** Key to status codes:**

FE	Federal Endangered
FT	Federal Threatened
FC	Federal Candidate
FD	Federal De-listed
BCC	USFWS Birds of Conservation Concern
SE	State Endangered
SD	State Delisted
ST	State Threatened
SR	State Rare
SSC	CDFG Species of Special Concern
CFP	CDFG Fully Protected Animal
WBWG	Western Bat Working Group High or Medium Priority species
List 1A	CNPS List 1A: Plants presumed extinct in California
List 1B	CNPS List 1B: Plants rare, threatened or endangered in California and elsewhere
List 2	CNPS List 2: Plants rare, threatened, or endangered in California, but more common elsewhere
List 3	CNPS List 3: Plants about which CNPS needs more information (a review list) *[not special status]*
List 4	CNPS List 4: Plants of limited distribution (a watch list) *[not special status]*

Species Evaluations:

No Potential. Habitat on and adjacent to the site is clearly unsuitable for the species requirements (cover, substrate, elevation, hydrology, plant community, site history, disturbance regime).

Unlikely. Few of the habitat components meeting the species requirements are present, and/or the majority of habitat on and adjacent to the site is unsuitable or of very poor quality. The species is not likely to be found on the site.

Moderate Potential. Some of the habitat components meeting the species requirements are present, and/or only some of the habitat on or adjacent to the site is unsuitable. The species has a moderate probability of being found on the site.

High Potential. All of the habitat components meeting the species requirements are present and/or most of the habitat on or adjacent to the site is highly suitable. The species has a high probability of being found on the site.

Present. Species was observed on the site or has been recorded (i.e. CNDDB, other reports) on the site recently.

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Photo credit: E. Tuttle

CHAPTER 5:
ICHTHYOFAUNA

Ballona Wetlands Ecological Reserve, Los Angeles, California
Santa Monica Bay Restoration Commission

Prepared for: California State Coastal Conservancy
June 2012

Author: Karina Johnston

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ICHTHYOFAUNA

INTRODUCTION

Defining the fish assemblage of a wetland can be difficult due to the highly mobile nature of the fauna. However, it is this mobility that often allows them to rapidly colonize restored habitats (Zedler 2001), indicating the need to collect consistent baseline information. Surveys at various spatial and temporal scales have identified wetland ichthyofauna throughout southern California wetlands using an assortment of methods (e.g. beach seines, enclosure traps, minnow traps, trawls, or purse seines) (Allen 1982, Yoshiyama et al. 1986, Zedler et al. 1992, Desmond et al. 2000, Zedler 2001). Employing a combination of survey methods to obtain data on fish abundances is often the most effective survey plan and minimizes error (Reed et al. 2002, Steele et al. 2006a, Steele et al. 2006b, Ambrose 2008, Merkel and Associates 2009).

The goals of the Baseline Assessment Program (BAP) for the Ballona Wetlands Ecological Reserve (BWER) ichthyofauna surveys included:

1) Assessing the distributions and relative abundances of fish species within the BWER tidal channels, Fiji Ditch, and Ballona Creek;
2) Assessing species richness within the same sites;
3) Comparing the results to previous BWER surveys; and
4) Developing a baseline for long-term monitoring.

All ichthyofauna nomenclature follows descriptions from "The Ecology of Marine Fishes: California and Adjacent Waters", Allen, L.G., D.J. Pondella II, and M.H. Horn (2006). University of California Press, Berkeley, California.

METHODS

Site Locations and Times

Beach seine surveys were conducted three times during the second Baseline Year: September 2010, April 2011, and June 2011. Shrimp trawls in Ballona Creek were conducted twice, once in July and once in September 2011. Tables 5.1 and 5.2 provide the dates and times of each fish survey event. No minnow traps were used for fish surveys in the second baseline year.

When possible, survey events occurred at least 72 hours after the last storm or rainfall event that produced more than 0.5 inches of rain to ensure there were no significant reductions in salinity. For each event, fish were surveyed during an incoming, semidiurnal spring tide once during the day and once again at night to provide a comparison of diurnal versus nocturnal fish activity and abundance. Surveys were conducted at the same stations as the first Baseline year (Johnston et al. 2011).

Table 5.1. Beach seine deployment dates for each fishing event at each survey station.

	STATION	DATE	START TIME	END TIME	DATE	START TIME	END TIME	DATE	START TIME	END TIME
Day	DITCH_A	9/27/2010	08:50	09:45	7/18/2011	10:49	12:00	4/17/2011	08:56	09:30
	DITCH_B	9/27/2010	----	----	7/18/2011	----	----	4/17/2011	----	----
	DITCH_C	9/27/2010	10:05	10:40	7/18/2011	12:20	12:35	4/17/2011	09:52	10:11
Night	DITCH_A	9/22/2010	19:30	19:52	7/18/2011	21:09	22:04	4/17/2011	19:30	20:30
	DITCH_B	9/22/2010	18:02	19:30	7/18/2011	22:16	22:50	4/17/2011	----	----
	DITCH_C	9/22/2010	19:55	20:50	7/18/2011	22:58	23:05	4/17/2011	20:42	21:06
Day	WETLAND_A	9/28/2010	09:11	10:30	7/17/2011	10:32	12:00	4/18/2011	09:15	10:22
	WETLAND_B	9/28/2010	10:45	11:15	7/17/2011	12:13	13:10	4/18/2011	10:32	11:23
	WETLAND_C	9/28/2010	11:30	12:05	7/17/2011	13:34	14:11	4/17/2011	12:00	12:40
Night	WETLAND_A	9/23/2010	20:06	20:18	7/17/2011	20:41	22:02	4/18/2011	20:21	21:32
	WETLAND_B	9/23/2010	20:46	21:14	7/17/2011	22:20	23:21	4/18/2011	21:44	22:32
	WETLAND_C	9/23/2010	21:49	22:14	7/17/2011	23:57	00:38	4/18/2011	21:54	22:35

Table 5.2. Ballona Creek deployment dates for shrimp/otter trawling.

DATE	START TIME	END TIME
7/19/2011	11:37	13:51
9/20/2011	10:44	13:42

Field Methods

Field methods were the same as those described in the Baseline Assessment Program: 2009-2010 Report, Chapter 5: Ichthyofauna (Johnston et al. 2011). Logistical constraints allowed day surveys only for Ballona Creek using the shrimp/otter trawl.

Fish were transferred immediately from the nets, cages, or trawl cod end into buckets filled with water from the survey station to be measured and identified to species using fish field guides (Miller and Lea 1972, Allen et al. 2006). All surveys were live catch and release.

Analysis Methods

Comparative graphs displaying results from both baseline years are used to indicate relative abundances and species richness. For detailed size and standard length data, see the first the Baseline Assessment Program: 2009-2010 Report, Chapter 5: Ichthyofauna (Johnston et al. 2011).

RESULTS

General Results and Overall Trends

Fifteen species of fish were caught in the Baseline surveys across both years (Table 5.3). During the second baseline year, 1,768 fish were caught using the beach seine method in the wetland and ditch sites, and 11 fish were caught in the trawls of Ballona Creek. Trash was recorded at every station during the beach seines and found in every shrimp/otter trawl, often dominated by plastics.

No fish were captured at station Ditch C during the April day surveys. Sampling was incomplete at station Ditch B during each day survey and the April night survey due to inaccessibility. Appendix A.1 includes a summary of water quality and weather data collected during the first Baseline year.

During the first surveys, locating the identifying characteristics of arrow gobies (*Clevelandia ios*) and cheekspot gobies (*Ilypnus gilberti*) in the field proved too time consuming, especially for the smaller individuals. While the first survey confirmed that almost all of the gobies were arrow gobies (>95%), cheekspot gobies may have been present. Therefore, both species will henceforth be referred to as 'arrow goby'.

Table 5.3. Species found in all BAP surveys. Note: asterisk denotes non-native species. Species marked with a '1' were present during the first baseline year, '2' for the second baseline year.

COMMON NAME	SPECIES	CODE	Fiji Ditch	Tide Channels	Ballona Creek
Arrow goby	*Clevelandia ios or Ilypnus gilberti*	CLIO	1, 2	1, 2	1
Bat ray	*Myliobatis californica*	MYCA			1
California halibut	*Paralichthys californicus*	PACA			1, 2
California killifish	*Fundulus parvipinnis*	FUPA	1, 2	1, 2	1
California lizardfish	*Synodus lucioceps*	SYLU			2
Diamond turbot	*Hypsopsetta guttulata*	HYGU		1, 2	2
Giant kelpfish	*Heterostichus rostratus*	HERO			2
Kelp bass	*Paralabrax clathratus*	PACL			2
Longjaw mudsucker	*Gillichthys mirabilis*	GIMI	1, 2	1, 2	
Pacific staghorn sculpin	*Leptocottus armatus*	LEAR	1, 2	1, 2	
Round stingray	*Urobatis halleri*	URHA	1, 2		
Specklefin midshipman	*Porichthys myriaster*	PONO			1
Striped mullet	*Mugil cephalus*	MUCE	1		1
Topsmelt	*Atherinops affinis*	ATAF	1, 2	1, 2	
Western mosquitofish *	*Gambusia affinis*	GAAF	1, 2		

Beach Seine Data

The most common fish caught using the beach seine method was topsmelt, with 593 individuals across all sites (Figures 5.1 and 5.2). Killifish and arrow gobies were the next most abundant species, with 516 and 382, respectively. The highest number of fish caught at any station was at Wetland A in September, with 273 fish (Figure 5.3). Figure 5.3 graphs include some bars with an asterisk (*), which represent stations where sampling events were missing, not a lack of fish.

Fish counts for the night surveys in the second baseline year were consistently higher than the day surveys (Figure 5.4). The September night surveys had the highest total number of fish (542). Of the day surveys, July had the most fish (286).

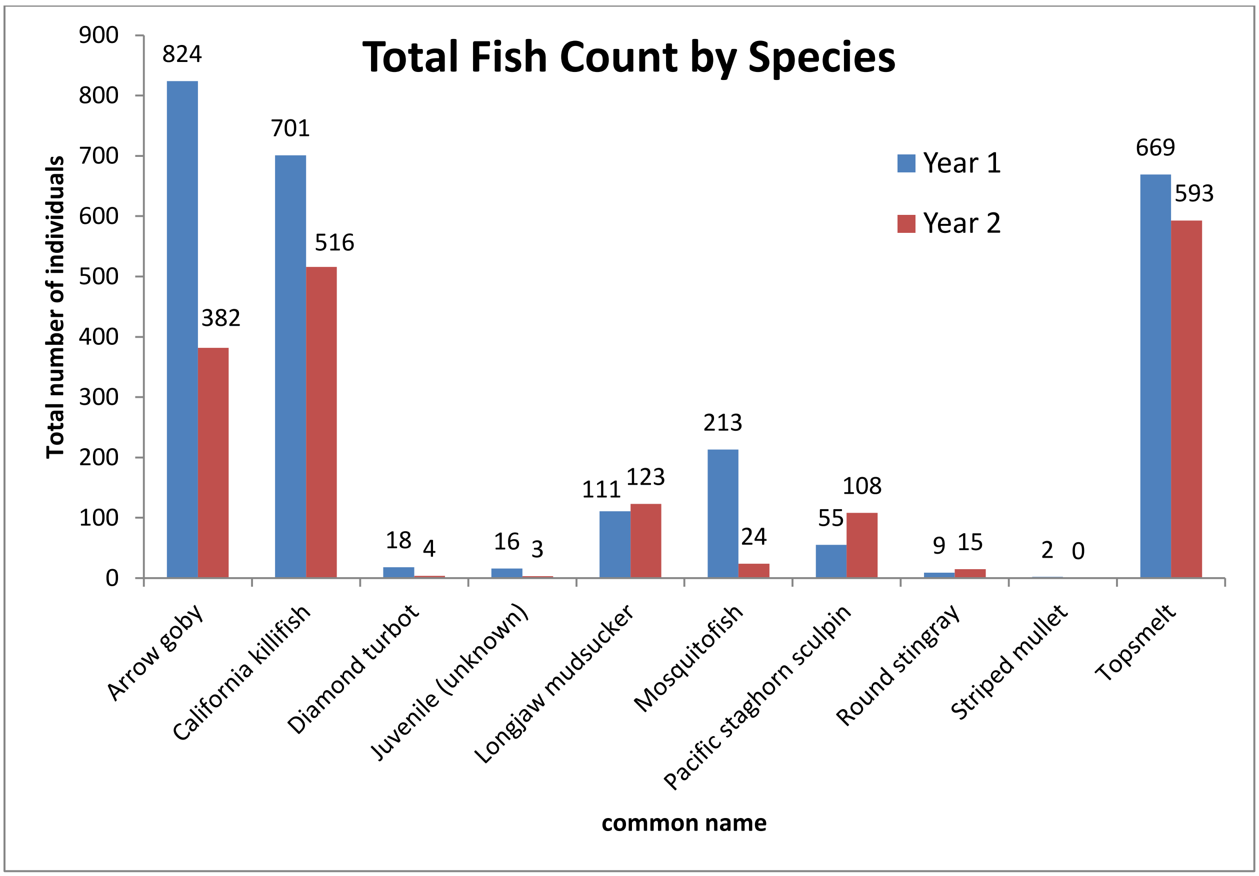
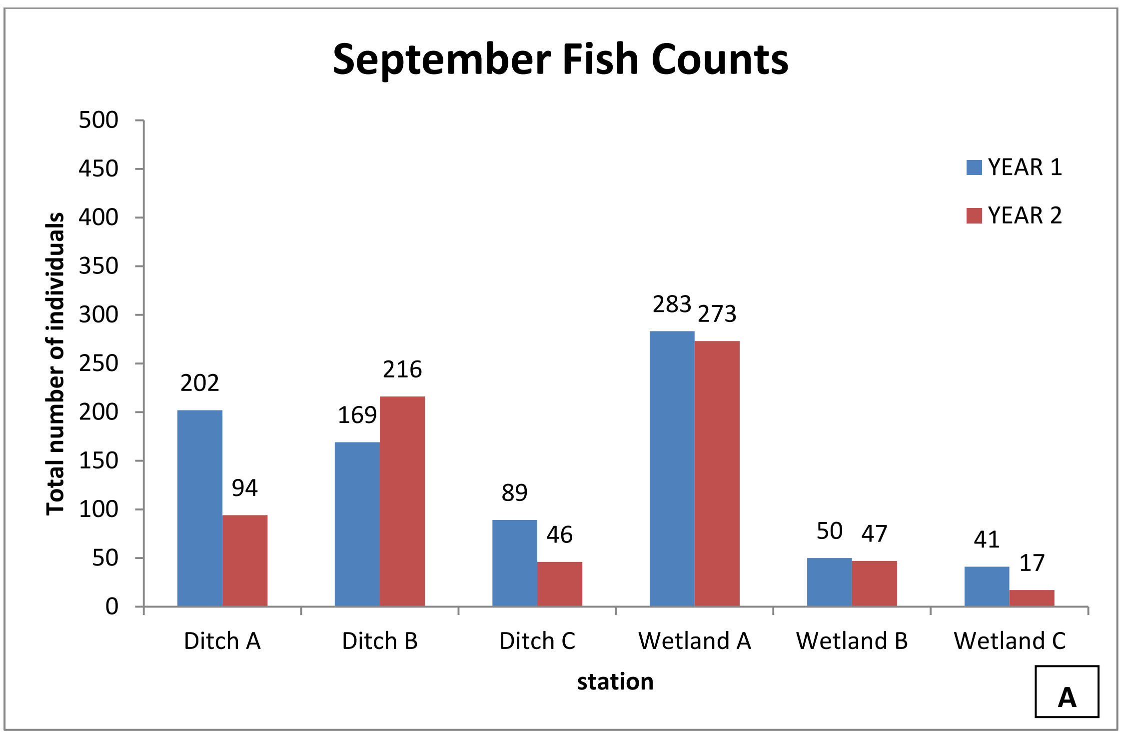
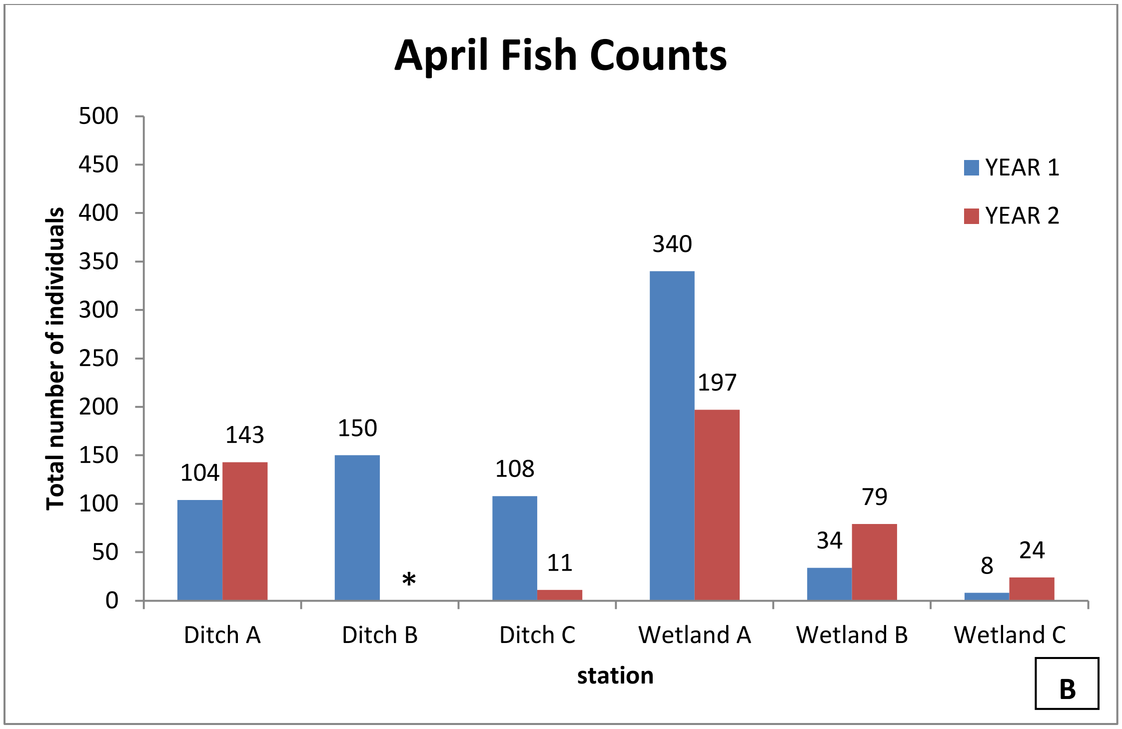


Figure 5.1. Total counts of each species of fish caught in the beach seine surveys across all stations throughout both baseline years. Note: Juvenile (unknown) represents juvenile fish that were too small to accurately identify in the field.

Figure 5.2. Photo of topsmelt during night fishing event (photo: SMBRC).





** = No fishing events, not a lack of fish present.*

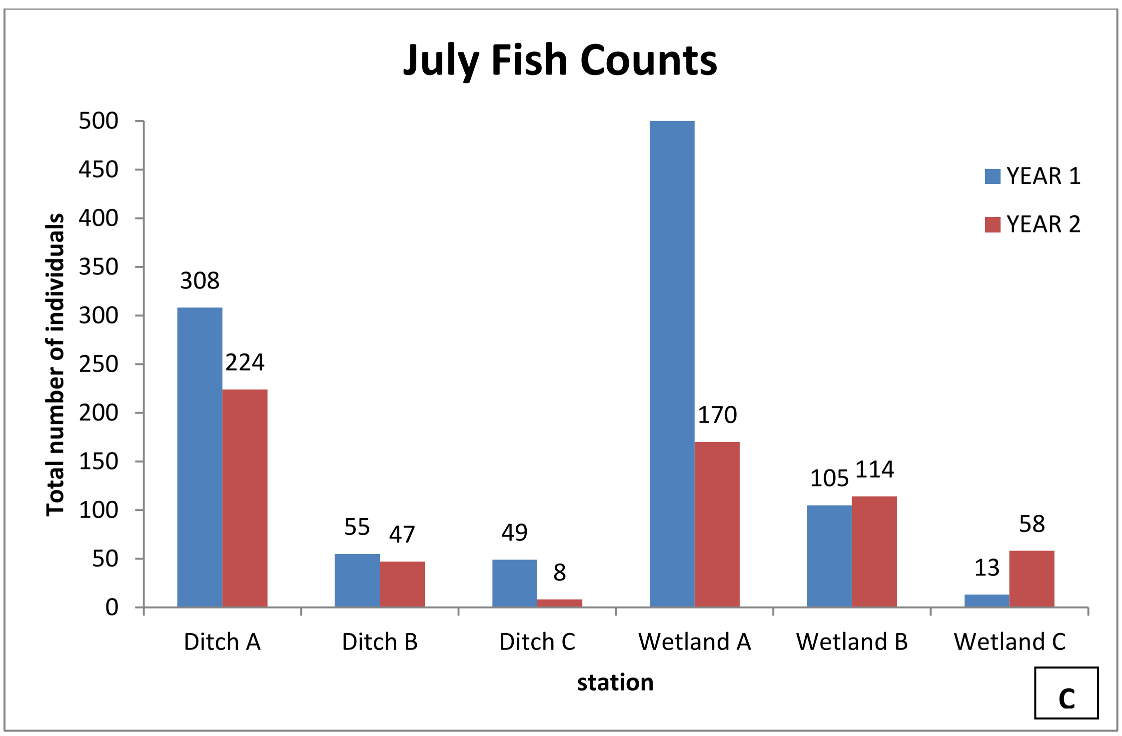


Figure 5.3. Total fish counts for each station in September (A), April (B), and July (C).

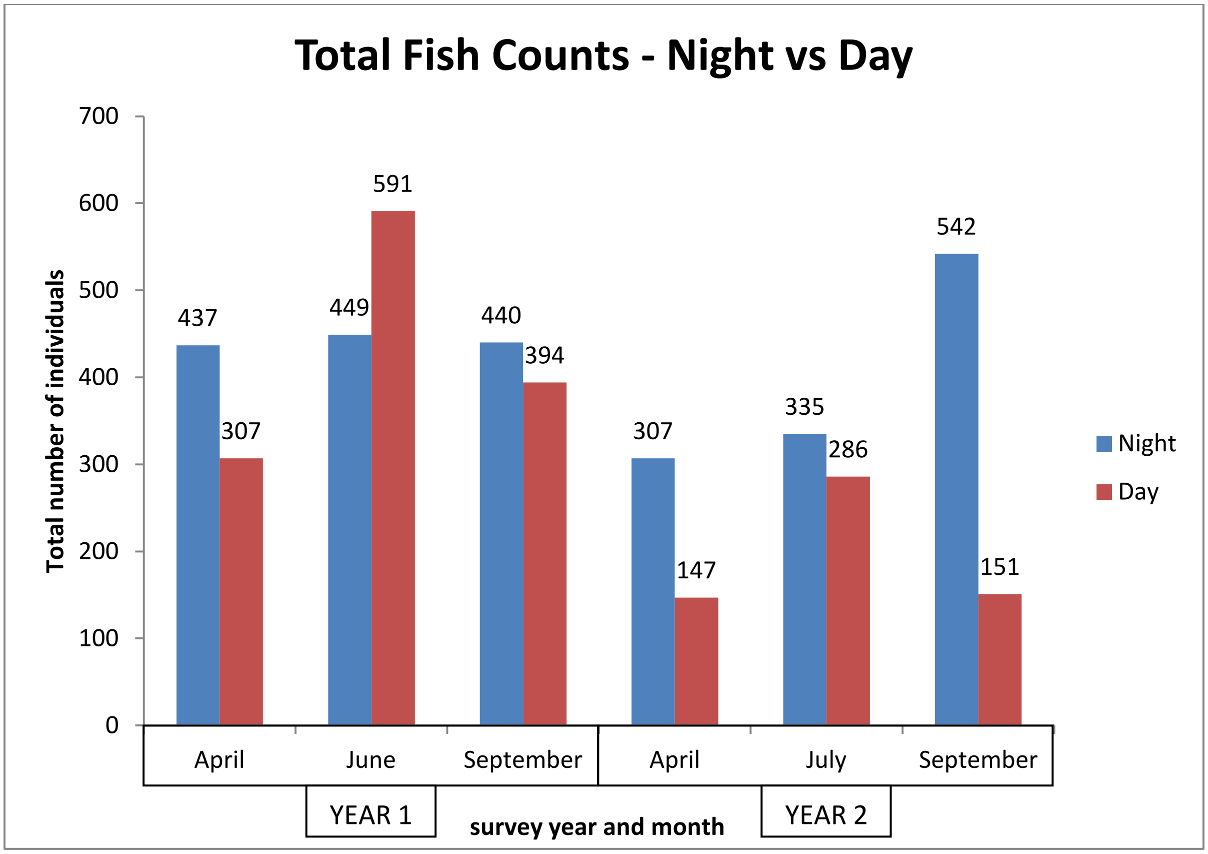


Figure 5.4. Total fish counts for day versus night surveys across both baseline survey years.

Killifish dominated the catch in the Fiji Ditch at the western stations nearest the tidal connection to Marina del Rey (Ditch A and B), but western mosquitofish dominated the catch at Ditch C which is more shallow, narrow, and further from the mouth. The principal species in the tide channel sites included both arrow gobies and topsmelt. Killifish were present at each station. The round stingray was found exclusively at the Fiji Ditch stations closest to the Marina del Rey connection (Ditch A and B).

No western mosquitofish were found in the tide channel Wetland stations, even though they have been found in historical surveys farther up the tide channels in the shallower habitats (PWA 2006). Western mosquitofish were found at all three Fiji Ditch stations and were the only non-native species captured using the beach seine method.

Shrimp Trawl Data

Eleven fish representing five species were found in the two shrimp/otter trawls in Ballona Creek (two in July and nine in September) (Table 5.4). Surveys occurred in daytime only during the second baseline year. The largest and most common fish caught was California halibut. Three species not previously identified on surveys were captured in the trawls, including: California lizardfish, kelp bass, and Giant kelpfish (Figure 5.5). In addition to the trawls, several species were observed in Ballona Creek next to the tide gates, including striped mullet, California killifish, and topsmelt.

Table 5.4. Individual fish identified in the Ballona Creek shrimp/otter trawls. Note: SL denotes standard length in millimeters.

MONTH	COMMON NAME	SCIENTIFIC NAME	SL (mm)
July	Giant kelpfish	*Heterostichus rostratus*	67
July	Giant kelpfish	*Heterostichus rostratus*	52
September	California halibut	*Paralichthys californicus*	199
September	California halibut	*Paralichthys californicus*	173
September	California halibut	*Paralichthys californicus*	174
September	California halibut	*Paralichthys californicus*	114
September	California halibut	*Paralichthys californicus*	118
September	California lizardfish	*Synodus lucioceps*	194
September	Diamond turbot	*Hypsopsetta guttulata*	165
September	Giant kelpfish	*Heterostichus rostratus*	96
September	Kelp bass	*Paralabrax clathratus*	65

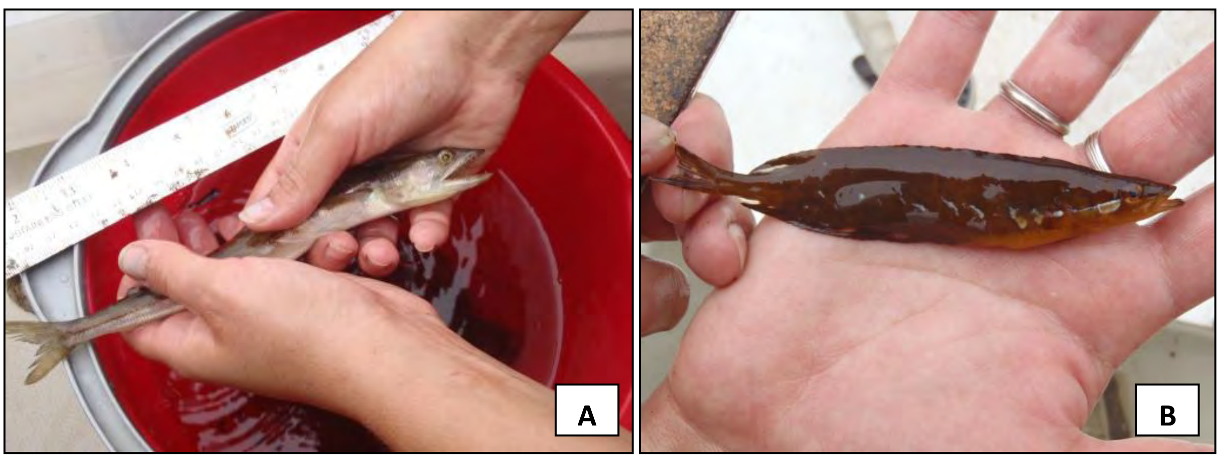


Figure 5.5. Photo of California lizardfish (A) and kelpfish (B) (photos: E. Del Giudice-Tuttle).

Special Status Species

No special status fish species were found during the first or second year BAP surveys. Appendix D.1 includes special status fish species with the potential to inhabit the BWER.

ANALYSIS OF BASELINE RESULTS

All fish species found during the BAP are representative of southern California estuarine marsh systems (Miller and Lea 1972, Moyle et al. 1995, Allen et al. 2006). Several fish species were ubiquitous across all survey stations, including the topsmelt and the arrow goby; the California killifish was also found at most stations. Those three species also represented the highest total counts for both survey years, indicating that the beach seine survey method was effective for fish species that are demersal, or bottom-dwelling (e.g. arrow gobies), and those that live within the water column (e.g. topsmelt). All stations within the BWER also had relatively similar species richness (Table 5.3), although the round stingray was found exclusively in the Fiji Ditch and the diamond turbot was found exclusively in the Wetland stations.

Similar patterns of spatial and temporal variations at the beach seine stations (i.e. not the Ballona Creek shrimp trawls) emerged across both years of fish surveys, although some fluctuations were identified. The closest stations to the self-regulating tide gates likely experience the highest amount of fluctuations in fish numbers entering and leaving the wetlands (i.e. station Wetland A).

The two years of trawls in Ballona Creek produced dissimilar species compositions and a low yield of fish per unit effort. This suggests that the survey mechanism may not be adequately representing the actual fish populations utilizing the Ballona Creek estuarine habitat. However, it is unclear from the results whether there is actually a dearth of fish using the Creek, or if the survey method is inadequate to produce accurate results. While the survey method should be appropriate for this habitat type, the dissimilar species observed each year, and the low relative abundances may not be indicative of the species utilizing the Creek. Additional surveys should be undertaken, potentially with multiple survey methods.

Overall, the muted nature of the tides allows several typical salt marsh fish species of southern California to access the tide channels of Area B, but prevents them from accessing and foraging the marsh plain habitats (e.g. high marsh); therefore the muted tides do not support the same fish nursery functions as a fully tidal system. Such habitat restrictions may impact the overall diversity and abundance of fish species. West and Zedler (2000) found that killifish in the Sweetwater Marsh National Wildlife Refuge consumed significantly more food when allowed access to the marsh plain in addition to tide channels. In the BWER, salt marsh fish populations may be limited by the smaller areas they are able to utilize (tide channels only). Various management objectives could significantly improve the habitat area, including opportunities to restore habitats used by rare or endangered species such as the steelhead trout or the tidewater goby.

For a detailed explanation of the muted tide system, refer to Chapter 11: Physical Characteristics for both baseline years (Johnston et al. 2011, 2012).

FUTURE DIRECTIONS

During the third year of surveys, only visual and anecdotal surveys will be conducted due to time constraints and sampling effort. Beach seines will be continued in the transition to long-term and regional wetland monitoring during the fourth year of surveys at the BWER. Shrimp/otter trawl surveys will be repeated opportunistically, pending the availability of a boat.

APPENDIX D.1

Special status ichthyofauna species with the potential to inhabit the Ballona Wetlands Ecological Reserve

Common Name	**Scientific Name**	**Status**
Arroyo chub	*Gila orcutti*	California Species of Special Concern
Santa Ana speckled dace	*Rhinichthys osculus*	California Species of Special Concern
Santa Ana sucker	*Castostomus santaanae*	Federally threatened
Steelhead trout	*Oncorynchus mykiss*	Federally threatened
Tidewater goby	*Eucyclogobius newberri*	Federally endangered
Unarmored threespine stickleback	*Gasterosteus aculeatus williamsoni*	Federally endangered

Note: All ichthyofauna nomenclature was cited from "The Ecology of Marine Fishes: California and Adjacent Waters", Allen, L.G., D.J. Pondella II, and M.H. Horn (2006). University of California Press, Berkeley, California.

Special status animal listings were extracted from the Department of Fish and Game's 2011 California Natural Diversity Database special animals list (accessed February 2011; http://www.dfg.ca.gov/biogeodata/cnddb/pdfs/SPAnimals.pdf).

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Photo credit: J. Goldfarb

CHAPTER 6:
HERPETOFAUNA

Ballona Wetlands Ecological Reserve, Los Angeles, California
Santa Monica Bay Restoration Commission

Prepared for: California State Coastal Conservancy
June 2012

Author: Karina Johnston

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HERPETOFAUNA

INTRODUCTION

Herpetofauna (amphibians and reptiles) are integral but undervalued components of natural ecosystems (Gibbons et al. 2000, Meyers and Pike 2006). Gibbons et al. (2000) reflect that declines of herpetofauna species diversity and population size can be attributed in part to causes including: anthropogenic factors, habitat loss, presence of invasive and introduced species, pollution, and disease. Site-specific lists of species' presence are important in the development of baseline information for a site, especially when directing conservation or management efforts (Tuberville et al. 2005); this information can also provide indicators of the health of a site.

The goal of the herpetofauna surveys for the Baseline Assessment Program (BAP) was to determine reptile species presence by habitat type throughout the Ballona Wetlands Ecological Reserve (BWER) and to contribute baseline information for future abundance and long-term monitoring surveys.

All herpetofauna scientific names in this report are cited using the *Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, With Comments Regarding Confidence in Our Understanding, Sixth Edition* by the Committee on Standard English and Scientific Names, Brian I. Crother, Chair, January 2008 (Society for the Study of Amphibians and Reptiles Herpetological Circular No. 37), henceforth referred to as SSAR 2008.

METHODS

A combination of survey methods is recommended to increase the probability of detecting the most species of herpetofauna (Mengak and Guynn 1987, Ryan et al. 2002, Fisher et al. 2008, Tuberville et al. 2005, Thompson and Thompson 2007). Survey methods may include combinations of pitfall traps (Fogarty and Jones 2003), coverboard arrays (Marsh and Goicochea 2003), funnel traps (Thompson and Thompson 2007), site searches, rock flipping, or targeted surveys for individual species (e.g. California legless lizard; Kuhnz et al. 2005).

Field Methods

The field methods used for the second baseline year of data collection were altered to assess a wider diversity of herpetofauna species and to address potential data gaps. Driftnet and pitfall arrays were not repeated due to the high effort, high impact, low species richness, and low capture rates found in the first baseline year. Instead, after a brief pilot test to make sure that coverboard arrays would capture both lizards and snakes, coverboard arrays were used in combination with site searches. All surveys were catch and release.

Surveys for terrestrial herpetofauna were primarily conducted using coverboard arrays. Coverboards were made of 60 x 122 x 1.1 cm plywood, labeled on one side with array and board number, placed flush against the ground to seal soil moisture, and covered with soil and natural debris for concealment (Figure 6.1). Where possible, boards were placed over non-gopher rodent burrows to increase survey success early in the season without the need for weathering of the boards (J. Goldfarb 2011, pers. comm.).

Figure 6.1. Individual cover board in grassland habitat of Area A (photo: SMBRC 2011).

Nineteen arrays with approximately 10 boards per array were placed in the three Areas of Ballona (190 total boards). No map is provided to protect the herpetofauna of the site from illegal collection activities. Two of the arrays in Area A were placed in upland grassland habitat, and one array was placed in upland scrub habitat. Five arrays in Area B were placed in upland dune habitat, two in high marsh, one in grassland, and three in transition areas between habitats. Four arrays in Area C were placed in grassland, and one array was placed in dune habitat. Boards were preferentially placed greater than 5 m apart to ensure proper coverage of the location; however, in certain locations, it was necessary to place them closer due to terrain limitations, such as dense or tall strands of vegetation. Boards were checked on a weekly basis during the fall season (October – December 2010) and again in the spring season (February – May 2011). Surveys were preferentially conducted two days after a rain event to achieve optimal soil moisture.

Captured individuals were identified by professional herpetologists using the *Field Guide to Western Reptiles and Amphibians* (Stebbins 2003), recorded, measured, photographed, and subsequently released back into the area of capture. When possible, tail length, snout-vent length, and sex were recorded. Physical parameters including temperature under the board, temperature directly adjacent to the board, and wind speed were recorded when an individual was present.

Intensive site searching was undertaken twice annually to detect species that may have been missed by the drift net arrays (e.g. turtles, salamanders, and semi-aquatic reptiles and amphibians). Holes, crevices, logs, rocks, and overhangs were thoroughly searched, and ancillary observations of herpetofauna were recorded during other surveys.

California Legless Lizard Surveys

The California legless lizard *(Anniella pulchra),* a California Species of Special Concern, was confirmed on site in the dune habitats of Area B in the first Baseline year (Johnston et al. 2011). In order to minimize habitat disturbance, legless lizard survey protocols were not repeated in the second year.

Laboratory and Analyses Methods

No laboratory methods were used in the herpetofauna surveys. Species' presences and an evaluation of the two primary survey methods were reported.

RESULTS

General Results and Overall Trends

In the second year of Baseline surveys, ten herpetofauna species were captured or observed on site including two species previously unidentified on site: garden slender salamander (*Batrachoseps major*) and San Bernardino Ring-necked snake (*Diadophis punctatus modestus*) (Table 6.1). An additional two non-native species were reported from visual observations during the second Baseline year in the adjacent Ballona Freshwater Marsh (FWM) (E. Read, pers. comm. 2012). Table 6.1 indicates all species present during the first two Baseline years using all methods, including: visual observations, cover board arrays, and pitfall and driftnet arrays.

Table 6.1. Herpetofauna species identified during the two Baseline years. Note: 'FWM' indicates species visually identified at the Ballona Freshwater Marsh adjacent to the site (E. Read, pers. comm. 2012). Species marked with an 'X' were present during surveys.

COMMON NAME	SCIENTIFIC NAME	STATUS	FWM	2010	2011
American bullfrog	*Rana catesbeiana*	Non-native species (introduced)	X		
Baja California treefrog	*Pseudacris hypochondriaca hypochondriaca*	Native species	X	X	**X**
California kingsnake	*Lampropeltis getula californiae*	Native species		X	**X**
California legless lizard	*Anniella pulchra*	California Species of Special Concern		X	**X**
Garden slender salamander	*Batrachoseps major*	Native species			**X**
Great Basin fence lizard	*Sceloporus occidentalis longipes*	Native species	X	X	**X**
Red-eared slider	*Trachemys scripta elegans*	Non-native species (introduced)	X		
San Bernardino Ring-necked snake	*Diadophis punctatus modestus*	Native species			**X**
San Diego alligator lizard	*Elgaria multicarinata webbii*	Native species		X	**X**
San Diego gopher snake	*Pituophis catenifer annectens*	Native species		X	**X**
Southern Pacific rattlesnake	*Crotalus oreganus helleri*	Native species		X	**X**
Western side-blotched lizard	*Uta stansburiana elegans*	Native species		X	**X**

The red-eared slider and bullfrog that were found in the FWM system were not surveyed for on the rest of the site due to lack of preferred habitat (E. Read, pers. comm. 2009). Both species are non-native and have been introduced to the southern California region (Stebbins 2003).

Coverboard Array Results

Lizards were the most abundant herpetofauna species found in the cover board surveys in the second baseline year, likely due to their higher abundances on site. The Great Basin fence lizard, western side-blotched lizard, and San Diego alligator lizard were all very common and found on all coverboard surveys. California kingsnakes (Figure 6.2) and San Diego gopher snakes were also ubiquitous throughout the habitats, based on the coverboard array results, though not found on every survey.

Several of the species found during the second baseline year were rarer based on the survey data results: one California legless lizard was found in the western dunes of Area B, two garden slender salamander was found in Area B east of the salt pan (Figure 6.2), and one San Bernardino ring-necked snake was found in central Area B. Additionally, several Southern Pacific rattlesnakes were identified on site, but were not present beneath the cover board arrays in the second year.

Figure 6.2. Garden slender salamander (A) and California kingsnake (B) found on the cover board surveys in Area B (photos: Jack Goldfarb).

Special Status Species

The only threatened, endangered, or California Species of Special Concern reported at the BWER is the California legless lizard (Hayes and Guyer 1981, Frank Hovore and Associates 1991, Impact Sciences, Inc. 1996). The California legless lizard was identified in the same dune habitats of Area B in both baseline years (Figure 6.3). Appendix E.1 contains special status herpetofauna species with the potential to inhabit the BWER.

Figure 6.3. California legless lizard found on the cover board surveys in Area B (photo: Jack Goldfarb).

ANALYSIS OF BASELINE RESULTS

Several reptile species are ubiquitous throughout the site and were found in almost every habitat (i.e. Great Basin fence lizard, Western side-blotched lizard, San Diego alligator lizard, and California kingsnake). Further population level analyses are not possible from these data; however, the cover board array method appears to reflect even the rare species present at the BWER (i.e. garden slender salamander, San Bernardino ring-necked snake, and California legless lizard).

The overall success of both of the primary survey methods (i.e. pitfall and driftnet arrays and cover board arrays) appears to vary based on species. While the lizards are adequately represented by both survey types, data points for snakes and amphibians only occurred on the cover board arrays. Due to the higher number of species successfully captured on the cover board arrays (8 herpetofauna species versus 3) and the high degree of variability in the capture rates of the pitfall and driftnet arrays from the first year (a range of 2.3% to 34.6%), an adaptive monitoring strategy would suggest retaining the sampling methods from the second baseline year into the long-term monitoring program. This is also reflected in the minimal effort that it will take to continue the surveys now that the boards are already placed.

Relative herpetofauna abundances from coverboard array surveys within the BWER were not possible. Seasonal differences affect overall numbers of species, but an additional reason was the presence of illegal 'herping' activities on site. The coverboard surveys at the BWER have been affected strongly by trespassers both through removal of kingsnakes and by lifting and disrupting the boards (Marsh and Goicochea 2003). Until further site restrictions are in place these data will not be comparable to other areas.

FUTURE DIRECTIONS

The monitoring program will continue during the third year at the BWER using coverboard arrays and walking searches, as these were found to be the most effective methods during the first two Baseline years. Professional herpetologists will continue to conduct the surveys.

APPENDIX E.1

Special status herpetofauna species with the potential to inhabit Ballona Wetlands Ecological Reserve

COMMON NAME	SCIENTIFIC NAME	STATUS
Arroyo toad	*Bufo californicus*	Federally Endangered / California Species of Special Concern
California legless lizard	*Anniella pulchra*	California Species of Special Concern
California red-legged frog	*Rana draytonii*	Federally Threatened / California Species of Special Concern
South coast garter snake	*Thamnophis sirtalis ssp.*	California Species of Special Concern
Coast horned lizard	*Phrynosoma blainvillei*	California Species of Special Concern
Southwestern pond turtle	*Actinemys marmorata pallida*	California Species of Special Concern
Two-striped garter snake	*Thamnophis hammondi*	California Species of Special Concern
Western spadefoot toad	*Spea hammondii*	California Species of Special Concern

NOTE: All herpetofauna scientific names are cited using the *Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, With Comments Regarding Confidence in Our Understanding, Sixth Edition* by the Committee on Standard English and Scientific Names, Brian I. Crother, Chair, January 2008 (Society for the Study of Amphibians and Reptiles Herpetological Circular No. 37).

Special status animal listings were extracted from the Department of Fish and Game's 2011 California Natural Diversity Database special animals list (accessed February 2011; http://www.dfg.ca.gov/biogeodata/cnddb/pdfs/SPAnimals.pdf).

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Photo credit: K. Johnston

CHAPTER 7:
MAMMALS

Ballona Wetlands Ecological Reserve, Los Angeles, California
Santa Monica Bay Restoration Commission

Prepared for: California State Coastal Conservancy
June 2012

Author: Karina Johnston

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INTRODUCTION

Mammals are an important link to functioning wetland and upland ecosystems within a complex food web (Mayfield et al. 2000). They can indicate change in overall vertebrate populations within a system, thereby serving as indicators of the overall health of the system (Manley et al. 2004). The Ballona Wetlands region has experienced a decline in the size of native species' populations, a reduction in several native species' ranges, and an increase in the types and population sizes of introduced species throughout the last century (Friesen et al. 1981).

The principle goal of the Baseline Assessment Program (BAP) mammal surveys was to identify mammal species inhabiting or utilizing the Ballona Wetlands Ecological Reserve (BWER). The BAP was comprehensive across the entire site, unlike previous studies which targeted particular areas or species. Several methods were used to identify groups of mammals varying in lifestyle and distribution.

All mammal nomenclature follows current citations from the Smithsonian Museum of Natural History, North American Mammals (searched January 2011; http://www.mnh.si.edu/mna/main.cfm).

METHODS

Small mammals, medium and large mammals, and vertebrate mortality rates were surveyed during the second Baseline year using Sherman traps, motion cameras, and visual mortality surveys.

Site Locations and Times

The BAP surveyed small mammals in the salt marsh habitats of Area B using baited Sherman live traps deployed as seven transects of approximately 100 m each with 10-15 m between traps, based on habitat type and terrain, for a total of 360 trap nights. Transects occurred in vegetation dominated by pickleweed (*Salicornia pacifica*[1]), saltgrass (*Distichlis spicata*), and some non-native grasses. Five were deployed in the marsh habitats north of Culver Blvd and two were deployed south of Culver and west of the Gas Company Road (Table 7.1, Figure 7.1). Surveys were conducted during late August and early September, 2011, primarily to assess the presence of the South Coast marsh vole (*Microtus californicus stephensi*), a California Species of Special Concern that was identified in surveys during the first baseline year (Chapter 7: Mammals, Johnston et al. 2011).

[1] Nomenclature according to Jepson Online Interchange (accessed 29 March, 2012); species was previously identified as *Salicornia virginica*.

Table 7.1. Small mammal transect deployment dates and trap nights.

Transect	Start Date	End Date	# of Nights	# of Traps	Trap Nights
SM 1	8/29/2011	9/9/2011	6	10	60
SM 2	8/29/2011	9/9/2011	6	10	60
SM 3	8/29/2011	9/9/2011	6	10	60
SM 4	8/29/2011	9/9/2011	6	10	60
SM 5	8/29/2011	9/9/2011	6	10	60
SM 6	9/6/2011	9/9/2011	3	10	30
SM 7	9/6/2011	9/9/2011	3	10	30
Totals	----	----	**36**	**70**	**360**

Figure 7.1. Map of seven small mammal transect locations within the BWER next to the tide gates (left) and the Gas Company Road (right).

Medium and large mammal sampling was conducted using baited Scout Guard camera stations. Twelve 'Critter Cam' stations were spread throughout the site during the second Baseline year for a total deployment of 631 days (Table 7.2). Deployment ranged from seven to 99 days based on trap success. Three Critter Cam stations were in Area A, seven were in Area B, and two were in Area C (Figure 7.2).

Both Sherman live trap and Critter Cam station methods followed protocols described in the first Baseline Report (Johnston et al. 2011).

Table 7.2. Critter Cam stations, deployment dates, and duration of deployment. See Figure 7.2 for map locations.

Camera Name	Area	Type	Latitude	Longitude	Deployment Date	Pull Date	Duration (days)
A - Open House	A	camera	33.9705	-118.4446	9/15/2011	10/13/2011	28
A - 2	A	camera	33.9731	-118.4400	4/6/2011	5/4/2011	28
A - West	A	camera	33.9729	-118.4431	4/6/2011	5/4/2011	28
B - 1	B	camera	33.9627	-118.4423	6/8/2011	9/15/2011	99
B - 2	B	camera	33.9635	-118.4408	6/8/2011	9/15/2011	99
B - 3	B	camera	33.9678	-118.4319	6/8/2011	9/15/2011	99
B - 4	B	camera	33.9701	-118.4351	6/15/2011	9/15/2011	92
B - 5	B	camera	33.9660	-118.4281	9/15/2011	10/13/2011	28
B - 6	B	camera	33.9653	-118.4267	9/15/2011	10/13/2011	28
B - salt pan	B	camera	33.9649	-118.4465	10/21/2010	10/28/2010	7
B - salt pan	B	camera	33.9649	-118.4465	11/24/2010	1/2/2011	39
C - Residential	C	camera	33.9787	-118.4316	4/6/2011	5/4/2011	28
C - Ballfields	C	video	33.9794	-118.4282	4/6/2011	5/4/2011	28

Vertebrate Mortality Surveys

Surveys to assess vertebrate mortality (roadkill) along roadways bisecting the BWER were conducted semi-monthly throughout the second baseline year. Each individual was identified to the lowest possible taxon along three transects (Figure 7.3), ranging from ‘unidentifiable’ in broad size classes to species-level data. Accuracy was to a tenth of a mile.

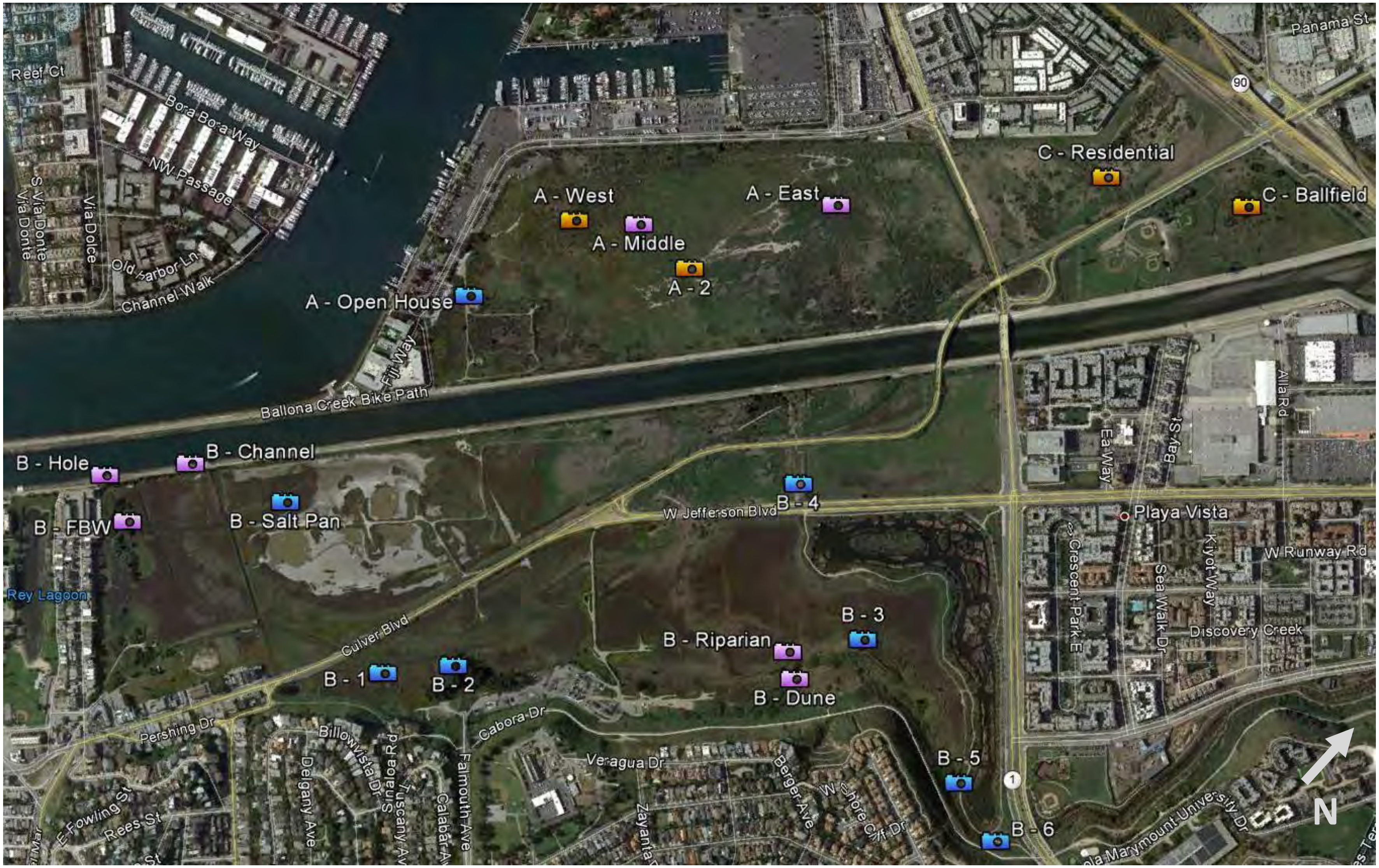

Figure 7.2. Map of Critter Cam stations throughout the BWER for the first Baseline year (pink), second Baseline year (blue), and stations monitored both years (gold).

Figure 7.3. Vertebrate mortality survey transects bisecting and adjacent to the BWER.

Analysis Methods

Results identify the presence of each species observed or captured in both Baseline years. Sherman trap data were also analyzed for capture rates (i.e. number of individuals divided by the total number of trap nights), and a subset of the Critter Cams was analyzed for relative frequency of occurrence. Data analysis did not include mark-recapture abundance information, since too few individuals were caught and there were too many unknowns (Nichols and Pollock 1983). Vertebrate mortality was analyzed by month and mile.

RESULTS

General Results and Overall Trends

In the second Baseline year, 14 species were captured or observed on site, including one California Species of Special Concern, the South Coast marsh vole (Table 7.3). When compared to the mammal species list from the first year of baseline surveys, the same mammal species were observed or captured with the exception of the house mouse (*Mus musculus*). This animal has most often been identified in the highly disturbed and berm habitats on site (W. Binder 2009, pers. comm.). A targeted survey for this species was not conducted, nor was it found in the Sherman traps in Area B. Table 7.3 includes those mammal species present during baseline surveys at the BWER during both survey years. Five of the 14 species recorded during the Baseline year are classified as non-native to the Ballona region, including: domestic cat, domestic dog, rat, Eastern fox squirrel, and Virginia opossum. Cats ranged from feral to domesticated, but occurrences of dogs appeared to be primarily off-leash domesticated animals.

The South Coast marsh vole was identified as present in Area B through visual observation in the appropriate habitat (salt marsh). The vole was observed and identified in the field to species (*Microtus californicus*), and understood to be the subspecies (*Microtus californicus stephensi*) as identification of the subspecies requires accurate skull measurements to be conducted. Confidence in the vole identification as the rare subspecies was high due to the habitat, historical presence, type locality, and voucher specimens of the subspecies housed in the Natural History Museum of Los Angeles. However, full taxonomic identification of the subspecies in the field is virtually impossible without sacrifice and conducting skull measurements (Jim Dines, Natural History Museum of Los Angeles; pers. comm., 2011).

Table 7.3. Species found during the two BAP years. Note: double asterisk denotes species captured during surveys several weeks before the first Baseline year began; CSC = California Species of Special Concern; V = visual identification; C = 'Critter Camera' identification; P = pitfall trap capture; S = Sherman trap capture; I = indirect evidence; A = auditory confirmation.

COMMON NAME	SCIENTIFIC NAME	STATUS	2009-2010	2010-2011
Botta's pocket gopher	*Thomomys bottae*	Native	V, P, I	V, I
California ground squirrel	*Spermophilus beecheyi*	Native	V, C, I	V, C, I
Coyote	*Canis latrans*	Native	C, I, A	V, C, I
Desert cottontail	*Sylvilagus audubonii*	Native	V, C, I	V, C, I
Domestic cat	*Felis cattus*	Non-native	V, C	V, C
Domestic dog	*Canis familiaris*	Non-native	V, C, I, A	V, C, I, A
Eastern fox squirrel	*Sciurus niger*	Non-native	V, C	V, C
House mouse **	*Mus musculus*	Non-native	S	---
Human	*Homo sapien*	Native	V, C, I, A	V, C, I, A
Raccoon	*Procyon lotor*	Native	V, C, I	V, C, I
Rat (unknown species)	*Rattus* sp.	Non-native	C	C
South Coast marsh vole	*Microtus californicus stephensi*	Native, CSC	S	V
Striped skunk	*Mephitis mephitis*	Native	C	V, C
Virginia opossum	*Didelphis virginiana*	Non-native	C	V, C
Western harvest mouse	*Reithrodontomys megalotis*	Native	V, S	V, P, S

Sherman Live Traps

During the second Baseline year, 48 western harvest mice were caught in the Sherman live traps (Table 7.4) and subsequently released. No other species were captured. In addition to the captures, twelve of the traps had mouse scat in them but no individuals. It is probable that the mice were not heavy enough to spring the trap closure mechanism. The overall capture rate was 13.3% (Table 7.4), or 16.7% with the scat evidence included as a single capture. The highest capture rate occurred on Transect SM 7 in the seasonal wetland habitat east of the Gas Company Road (63.3%).

Table 7.4. Results for year 2 small mammal BAP surveys using Sherman live traps.

Transect	Habitat	Species	Trap Nights	# of Captures	Capture Rate
SM 1	High Marsh	Harvest Mouse	60	9	15.0%
SM 2	High Marsh	Harvest Mouse	60	2	3.3%
SM 3	High Marsh	Harvest Mouse	60	1	1.7%
SM 4	High Marsh	Harvest Mouse	60	1	1.7%
SM 5	High Marsh	Harvest Mouse	60	12	20.0%
SM 6	Seasonal Wetland	Harvest Mouse	30	4	13.3%
SM 7	Seasonal Wetland	Harvest Mouse	30	19	63.3%
Total	**----**	**----**	**360**	**48**	**13.3%**

Critter Cam Stations

Twelve Critter Cam stations recorded 16 species throughout the BWER in the second baseline year (Table 7.5). Twelve species were mammals and four species were birds. Four species of mammals were recorded in Area A, eleven in Area B, and six in Area C. The desert cottontail was fairly ubiquitous throughout the site; it was observed the most frequently of all mammals and was recorded at the highest number of stations. Several mammal species were seen exclusively within Area B: raccoon (Figure 7.4), striped skunk, and domestic cat (Table 7.5). Cameras B-5 and B-6 at the southeastern corner of the BWER by the Freshwater Marsh had low species diversity, and the Critter Cams predominantly captured people walking their dogs off-leash (Figure 7.4), or out running.

Neither native (grey) nor non-native (red) foxes were identified in the BAP surveys, though the red fox was identified as present via photographs in the adjacent Playa Vista riparian corridor. Additional mammal presence was evaluated using indirect evidence, i.e. scat, paw prints, and vocalizations (Table 7.3).

Figure 7.4. Critter Cam photos of two off leash dogs (left) and a raccoon (right) at Critter Cam B-1. For more Critter Cam photos, access our Flickr website: www.flickr.com/ballonarestoration.

Table 7.5. List of all species recorded by the Critter Cams in each Area of the BWER for both baseline survey years. Note: asterisk denotes non-native species. Species marked with an 'X' were present during surveys.

YEAR 1 PRESENCE RESULTS

		Area A					Area B					Area C	
Common Name	**Scientific Name**	**A - Middle**	**A - 2**	**A - 3**	**A - West**	**A - East**	**B - Dune**	**B - Hole**	**B - Channel**	**B - FBW**	**B - Riparian**	**C - Ballfields**	**C - Residential**
California ground squirrel	*Spermophilus beecheyi*						X	X		X			
Cottontail	*Sylvilagus audubonnii*		X	X	X	X	X	X	X	X	X	X	X
Coyote	*Canis latrans*		X	X	X		X		X				
Raccoon	*Procyon lotor psora*						X	X		X			
Rat *	*Rattus* sp.											X	
Striped skunk	*Mephitis mephitis*						X						
Virginia opossum *	*Didelphis virginiana*						X	X		X	X	X	
American crow	*Corvus brachyrhynchos*					X		X	X				
Mourning dove	*Zenaida macroura*						X						
Egret	*Ardea* sp.	X	X	X									
Great blue heron	*Ardea herodias*	X											
Northern Harrier	*Circus cyaneus*		X										
Sparrow	*Passerculus sandwichensis (spp.)*		X									X	
Domestic cat *	*Felis cattus*						X	X		X	X		
Domestic dog *	*Canis familiaris*		X			X		X		X			
Human	*Homo sapien*		X	X		X	X	X		X		X	

YEAR 2 PRESENCE RESULTS

		Area A			Area B							Area C	
Common Name	**Scientific Name**	**A - 2**	**A - West**	**A - Open House**	**B - Salt Pan**	**B - 1**	**B - 2**	**B - 3**	**B - 4**	**B - 5**	**B - 6**	**C - Ballfields**	**C - Residential**
California ground squirrel	*Spermophilus beecheyi*					X	X		X	X		X	
Cottontail	*Sylvilagus audubonii*	X	X		X	X	X	X	X			X	X
Coyote	*Canis latrans*	X	X	X	X				X				X
Eastern gray squirrel *	*Sciurus niger*						X					X	
Raccoon	*Procyon lotor psora*				X	X	X	X			X		
Rat *	*Rattus sp.*	X	X			X	X						
Striped skunk	*Mephitis mephitis*							X					
Virginia opossum *	*Didelphis virginiana*					X	X	X	X				X
American crow	*Corvus brachyrhynchos*	X			X				X				
Great blue heron	*Ardea herodias*					X							
Hummingbird sp.	Trochilidae						X						
Sparrow	*Passerculus sandwichensis (spp.)*	X	X			X		X					
Domestic cat *	*Felis cattus*			X		X							
Domestic dog *	*Canis familiaris*			X		X	X	X		X	X	X	
Human	*Homo sapien*			X		X	X		X	X	X		

Vertebrate Mortality

In Year 2 of the baseline surveys, 66 transects in 22 individual surveys across 11 months were completed. In all surveys combined, 191 incidences of vertebrate mortality were identified. The most commonly identified vertebrate mortality species over the course of the second baseline year were cottontail rabbits, squirrels, and opossums. However, several large mammals were also identified along the transects over the course of the year, including two coyotes, one large domestic dog, two raccoons, and several additional large mammals that were unidentifiable.

The highest average kill rate was in September (4.7 kills/mi), followed by August (4.2 kills/mi) (Figure 7.5). There was a trend of increasing mortality beginning in mid-spring through the end of summer. Transect 3, along Jefferson/Culver Boulevards, had the highest total number of kills (77), followed by Transect 2 (Culver Boulevard east) with 68 kills, and lastly by Transect 1 (Lincoln Boulevard) with 46 kills. The highest total number of kills for all three transects occurred in September.

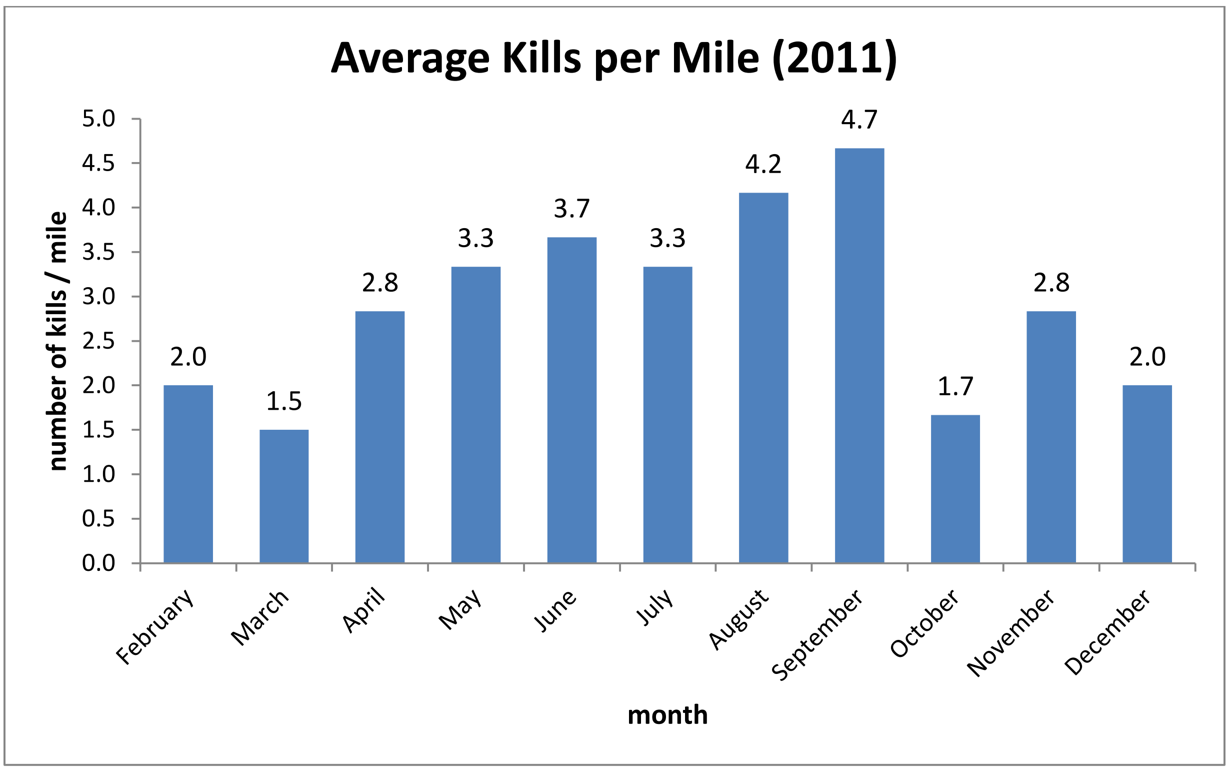

Figure 7.5. Vertebrate mortality along three transects bisecting the BWER (kill rate expressed as average number of kills per mile).

Special Status Species

A California Species of Special Concern, the South Coast marsh vole, was present in the small mammal live traps in Area B in the first Baseline year (Table 7.3). During the second year, although it was not captured, it was identified twice visually in the salt marsh habitat of Area B. This subspecies was also found in previous surveys in Areas A and B (Friesen et al. 1981, Hovore 1991, Impact Sciences, Inc. 1996, Psomas and Associates 2001). Past surveys have captured the vole most often in marsh habitats containing saltgrass.

The southern California saltmarsh shrew was found in previous surveys in Area B (Friesen et al. 1981, Frank Hovore and Associates 1991), but not in subsequent surveys or reports. While the Baseline program did not identify this species on site, areas that may contain suitable habitat for the California saltmarsh shrew will continue to be surveyed during the next monitoring year.

The San Diego black-tailed jackrabbit was not found in 1,058 Critter Cam trap nights across two years. No special status mammal species have been documented within Area C (PWA 2006). Appendix F.1 contains a full list of the special status mammal species with the potential to inhabit the BWER.

ANALYSIS OF BASELINE RESULTS

Both years of baseline surveys yielded the same species of mammals, but with additional new data regarding each species' range, based on the Critter Cam data. For example, the cottontail rabbit and humans were the only two mammal species identified via Critter Cam as having a site-wide presence in the first year, but during the second year coyotes were newly identified utilizing Area C. Additionally, similarly to the first year, incidences of off-leash dogs occurred in all Areas. The overall site use of mammals appears to be widespread, covering all habitat types.

Warmer months corresponded with increasing mortality for vertebrates along the road transects surveyed. The species with the highest number of roadkill incidences overall, the cottontail rabbit, was also the species most frequently identified in the Critter Cam motion camera stations. The next step for analyzing these data is to identify the specific locations that have the most frequent number of mortalities, as well as those areas that may have the greatest number of large mammal mortalities. For example, both coyote collisions occurred along Lincoln Boulevard. Although it had the lowest overall kill rate, it tended to have a higher proportion of the total larger size-class mammals. These data will be important in identifying areas that would be the most appropriate for the creation of protected wildlife crossings and corridors and/or traffic modifications.

When comparing the first two years of Sherman trap data (small mammals), the western harvest mouse was present in all areas and habitats except upland scrub. The lack of presence in the scrub may be due to the high degree of trap tampering in that habitat by both coyotes and crows. Very few successful trapping nights were possible during the first year within scrub habitat in Areas A and C. Sherman trap sampling was also used to target habitat use by the South Coast marsh vole during the second year of sampling in the marsh habitats of Area B. While the vole was not identified in trap surveys during the second year, it was visually confirmed to be present in the high marsh habitat of Area B. Survey results obtained using the Sherman trap method appear to under-represent the true mammal species diversity at the BWER (K. Johnston, personal observation). Our cost-benefit analysis found that the sampling effort required for this method resulted in low species diversity of capture, trap tampering, and a substantial difference in capture success rates (i.e. range of 0.0 – 4.17% in year 1 compared to 1.7 – 63.3% in year 2). Therefore, the Sherman trap method should be removed from the monitoring program when using an adaptive strategy to transition to long-term monitoring.

Adaptive monitoring allows programs to evolve iteratively (Lindenmayer and Likens 2009); in this case, adaptive monitoring allows for comparative assessments of sampling effort versus the information gained from each method. When assessing the first two years of baseline data collected at the BWER, the Critter Cam data more clearly answers the question of mammal species' use of the BWER, with a much smaller sampling effort required for implementation. Small mammals will continue to be assessed visually to better employ the most cost effective survey strategy. This assessment will allow a reduction in sampling effort during the long-term monitoring program beginning in year 3.

FUTURE DIRECTIONS

As the Baseline program transitions to a long-term monitoring program, mammal surveys will be reduced. Large mammal surveys will continue using the Critter Cam stations throughout non-winter months (i.e. April through October 2011) in the areas identified as data gaps during the first two Baseline years.

Bats are known to forage on site (PWA 2006), but will not be surveyed as part of the Baseline Assessment Program. If funding becomes available, bat surveys may be included at a later time.

APPENDIX F.1

Special status mammal species with the potential to inhabit Ballona Wetlands Ecological Reserve

COMMON NAME	SCIENTIFIC NAME	STATUS
Southern California saltmarsh shrew	*Sorex ornatus salicornicus*	California Species of Special Concern
San Diego black-tailed jackrabbit	*Lepus californicus bennetti*	California Species of Special Concern
South Coast marsh vole *	*Microtus californicus stephensi*	California Species of Special Concern
California leaf-nosed bat	*Macrotus californicus californicus*	California Species of Special Concern
Long-eared myotis bat	*Myotis evotis*	California Species of Special Concern
Pacific pocket mouse	*Perognathus longimembris pacificus*	Federally Endangered
Pale Townsend's big-eared bat	*Corynorhinus townsendii pallescens*	California Species of Special Concern
Pallid bat	*Antrozous pallidus pacificus*	California Species of Special Concern
Western mastiff bat	*Eumops perotis californicus*	California Species of Special Concern
Yuma myotis bat	*Myotis yumanensis*	California Species of Special Concern

Note: All mammal nomenclature follows current citations from the Smithsonian Museum of Natural History, North American Mammals (searched January 2011; http://www.mnh.si.edu/mna/main.cfm). Asterisk indicates species found during the second Baseline year.

Special status animal listings were extracted from the Department of Fish and Game's 2011 California Natural Diversity Database special animals list (accessed February 2011; http://www.dfg.ca.gov/biogeodata/cnddb/pdfs/SPAnimals.pdf).

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CHAPTER 8:
AVIFAUNA

Ballona Wetlands Ecological Reserve, Los Angeles, California
Santa Monica Bay Restoration Commission

Prepared for: California State Coastal Conservancy
June 2012

Authors: Dan Cooper, Ivan Medel, and Karina Johnston

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AVIFAUNA

INTRODUCTION

The presence and distribution of avifauna within an ecosystem is often used as an index of habitat quality due to avian diets and their vulnerability to environmental conditions (Conway and Droege 2006, Conway 2008). Certain bird species presence has also been used as a measure of success of wetland restoration efforts in coastal southern California (Cooper 2008). Bird communities are in constant flux. Because turnover in isolated sites can be high from decade to decade with new species colonizing and rare species becoming extirpated (MacArthur and Wilson 1967, Cooper 2006), regular, repeated surveys are needed to maintain a clear picture of bird communities on a site.

The Baseline Assessment Program (BAP) provides the first comprehensive assessment of the avifauna of the Ballona Wetlands Ecological Reserve (BWER) using original research since 1992. The BAP builds on previous assessments from 1981 and 1943. The goals of the avifauna surveys of the BWER included:

1) Develop georeferenced maps of species distributions across several seasons;
2) Collect data on waterbirds along Ballona Creek, an identified data gap; and
3) Supplement historical avifauna records with contemporary reserve-wide baseline surveys.

All bird nomenclature follows current citations from the American Ornithologists' Union's check-list of North American birds (7th Edition, 1998).

METHODS

Reserve-wide Survey Methods

Two reserve-wide surveys were conducted as extensive area-searches (excepting Ballona Creek) during the second Baseline year to capture a seasonal snapshot of avian activities and distributions across the terrestrial habitats of the BWER. Semi-annual surveys were conducted over multiple days in October 2010 and April 2011. Surveys were conducted between 0600 and 1130, following protocols described in the first baseline year report (Chapter 8: Avifauna; Johnston et al. 2011).

Waterbird Survey Methods

Waterbird surveys consisted of single-day, bi-monthly counts of waterfowl, shorebirds and other species along the Ballona Creek channel. Sampling occurred in December 2010 and February, June, April, and August 2011. Protocols were modified to include only one site visit per day for the second baseline year to reduce the time and effort needed to monitor baseline species usage and because a similar array of species was detected on both days of the two-day waterbird surveys.

Special-status Species Survey Methods

Protocol surveys for special-status species were performed for the Light-footed Clapper Rail [*Rallus longirostrus levipes* (Federally/State Endangered)] and for the California Gnatcatcher [*Polioptila californica* (Federally Threatened)] during the second baseline year. The Light-footed Clapper Rail survey included six visits between 10 March and 10 April 2011 (Ryan 2011), and the California Gnatcatcher survey included six visits between 18 March and 18 May 2011 (Cooper 2011a, 2011b).

Protocol surveys were performed following accepted guidelines developed by the appropriate regulatory agencies (e.g. Fish and Wildlife 2001).

RESULTS

During the second year baseline bird surveys, 135 bird species and distinct subspecies[1] (hereafter "species") were recorded (all survey types included) (Table 8.1). The reserve-wide surveys identified 101 species in October 2010 and April 2011. The bi-monthly waterbird surveys identified 67 species along lower Ballona Creek from October 2010 to August 2011. A table of all bird species detected during the second baseline year (October 2010 - September 2011) and the survey on which they were observed is provided in Appendix G.1.

These surveys found comparable numbers of species as those conducted during the first baseline year, which recorded 109 species on the October 2009 and April 2010 reserve-wide surveys, and 85 on the waterbird surveys (conducted twice as often), for a total of 154 species (Table 8.1).

Table 8.1. Numbers of species found on each type of survey across both baseline years.

Survey Type	# Species: Year 1	# Species: Year 2
Reserve-wide surveys (October & April)	109	101
Waterbird surveys (all)	78	67
TOTAL	**154**	**135**

[1] An effort was made to distinguish between the more distinctive subspecies where possible, e.g., "Audubon's" vs. "Myrtle" Yellow-rumped Warbler. These were treated as separate entities in the surveys and analyses. This total excludes incidental reports made outside the scope of the BAP surveys.

A total of 36 bird species were found on both October 2010 and April 2011 reserve-wide surveys, and five species were found on all waterbird survey visits; just two bird species were present on *all* reserve-wide and all waterbird surveys [i.e. Great Blue Heron (*Ardea herodias*) and Gadwall (*Anas platyrhynchos*)].

Reserve-wide Survey Results

Bird species richness was similar between both the first and second baseline year reserve-wide surveys (68 species in October 2010 vs. 64 species in October 2009; 69 species in April 2011 vs. 72 species in April 2010). However, species richness alone contains little useful information, since it does not reflect site usage (e.g. distribution, habitat use, abundance) by individual bird species. Tracking the relative abundance of particular species across years and between seasons can give a more informed description of site usage by birds. For example, 11 of the 15 most abundant species were the same across both baseline years, and the top two most abundant species during both baseline years were the House Finch (*Carpodacus mexicanus*) and the White-crowned Sparrow (*Zonotrichia leucophrys*).

Changes in abundance and distribution of particular special-interest species, such as the State Threatened Belding's Savannah Sparrow (*Passerculus sandwichensis beldingi*), may be tracked by assessing spatial variation from year-to-year using these same baseline data. Figure 8.1 shows the distribution of the Belding's Savannah Sparrow during the first (October 2009 and April 2010 only) and the second (October 2010 and April 2011) baseline years. These data are preliminary, but suggest the distribution pattern of Belding's Savannah Sparrows varies somewhat along the edges of its range, but remains similar from year-to-year. Birds are located mainly around the saltpan and tidal channels north of Culver Boulevard, with scattered sightings elsewhere in *Salicornia* spp. (pickleweed).

Seasonal differences in distribution of many species are also readily visible using the baseline data. Figure 8.2 shows the distribution of the Common Yellowthroat (*Geothlypis trichas*) at two different times of year, April and October, illustrating the different areas used by the species during the breeding season (April) and post-breeding season (October). Note the contraction in range of the species following the nesting season (April to October), particularly from the northeastern portions of each Area.

The surveys have also clarified ranges of several sensitive and/or high-interest bird species at the BWER, such as the Western Meadowlark (*Sturnella neglecta*), which has recently been on the decline in coastal southern California (Unitt 2004, Allen et al. 2009). The Western Meadowlark was encountered mainly in short-grass vegetation and drier portions of the salt marsh, usually in the center of the open space parcels of the BWER, far from the edges. Figure 8.3 depicts year-round distribution of the Western Meadowlark at the BWER during the second baseline year. A similar distribution pattern for the Western Meadowlark was found in the first base line year.

Temporal and geospatial patterns of various species, such as annual change in abundance or distribution across habitat types may inform restoration planning and management decisions. This is particularly evident in the results for the more abundant species in the BWER, such as the Common Yellowthroat (Figure 8.4) and Belding's Savannah Sparrow (Figure 8.1). Distribution patterns for these species tend to align with particular habitat and vegetation types which may be afforded special considerations when making restoration and management decisions, specifically for special-status species or those breeding on site in particular habitats.

Figure 8.1. Distribution of the Belding's Savannah Sparrow identified in October and April surveys in Year 1 (pink) and Year 2 (green).

Figure 8.2. Distribution of the Common Yellowthroat at the BWER during the April breeding survey (green) and October non-breeding survey (pink). Note: Pin numbers indicate individual numbers of birds.

Figure 8.3. Distribution of the Western Meadowlark (*Sturnella neglecta*). Pink pins denote October 2010 birds; green pins denote April 2011 birds. Note: Pin numbers indicate individual numbers of birds, with stars denoting >10 individuals.

Figure 8.4. Distribution of Common Yellowthroat identified in October and April surveys in Year 1 (pink) and Year 2 (green). Note similar distribution between years, clustered only in areas with taller vegetation.

Waterbird Survey Results

Sixty-seven species were recorded along the Ballona Creek channel during five, one-day waterbird surveys from fall 2010 through summer 2011 (December 2010, February 2011, April 2011, June 2011, and August 2011). February 2011 had the highest numbers of individual birds (2,009 individuals of all species combined), with December 2010 (1,458 individuals) ranking second-highest. June 2011 had the lowest usage of Ballona Creek (188 individuals). December 2010 had the highest species richness (43 species), whereas June 2011 saw the lowest (19 species). The two most numerous species along Ballona Creek (all months combined) were two species of shorebirds: Willet (*Catoptrophorus semipalmatus*) and Black-bellied Plover (*Pluvialis squatarola*). Both Willet and Black-bellied Plover were also the species with the highest recorded single-day totals along the creek during the second baseline year (768 individual Willets in August 2011 and 504 Black-bellied Plovers in February 2011).

The western portion of the Ballona Creek survey area supported the widest diversity of waterbirds when assessed by species richness. However, a few species, mainly those that prefer freshwater or shallow wetlands, showed a clear preference for the upstream reaches of the Ballona Creek waterbird survey area. These species included Gadwall, Mallard (*Anas platyrhynchos*), Ruddy Duck (*Oxyura jamaicensis*), American Coot (*Fulica Americana*), Black-necked Stilt (*Himantopus mexicanus*), and Green-winged teal (*Anas crecca*).

The upper portions of the Ballona Creek waterbird survey areas (Lincoln Blvd. to the 90 freeway) also supported a higher species and total quantity of gull species than portions closer to the coast. Over 1,100 individuals representing five species were detected in the second baseline year (all visits combined). Similarly to observations in the first baseline year, gulls prefer the sandy-bottomed intertidal sections of the creek at low tide for roosting activities.

Special-status Species Results

Consistent site usage by special-status bird species' can be problematic to asses, though the data provide useful management information. Special-status species recorded as simply flying over a site, or present only for a few days during migration, are generally not given any additional protection. Small, isolated sites like the BWER tend to support only a small number of nesting and/or wintering special-status species, though many more might occur in migration.

Appendix G.2 contains a list of all special-status bird species observed during surveys in the second Baseline year. A total of 26 special-status species were detected during the second baseline year (vs. 28 species in the first year). This total includes vagrant species that use the site very briefly, or in small numbers, presumably en route to breeding or wintering grounds elsewhere. Within Appendix G.2, species detected in the roles for which they are afforded special-status (e.g. breeding and/or wintering) are marked with a "P". Eight such species were detected in the second baseline year and nine in the first year, suggesting some continuity between years.

Two separate special-status species surveys were conducted concurrently with the BAP to assess the nesting status of two rare species recorded recently at BWER, the Light-footed Clapper Rail (Federally/State Endangered) and for the California Gnatcatcher (Federally Threatened) (Figure 8.5). No Light-footed Clapper Rails were found, and only one California Gnatcatcher was detected (during one out of the six protocol surveys), confirming that neither maintains a population at BWER (Cooper 2010a, 2010b).

Figure 8.5. Photo of California Gnatchatcher on 17 August 2011 (photo: D Cooper).

One special-status species, the Belding's Savannah Sparrow, was confirmed as nesting within the BWER in the second baseline year (Figure 8.6). This species was largely confined to pickleweed (*Salicornia* spp.) dominated areas in the western portion of Area B. Most individuals were found north of Culver Boulevard. However, small numbers of Belding's Savannah Sparrows were also recorded along Ballona Creek on several of the waterbird surveys (April and June 2011).

Two special-status species detected are typically afforded protection under CEQA year-round: Burrowing Owl (*Athene cunicularia*) and California Gnatcatcher (*Polioptila californica*). A single Burrowing Owl was recorded once in Area B in October 2010 (but was not seen thereafter). Two California Gnatcatchers over-wintered in Area C in 2010-11. These two individuals were first recorded on 23 October 2010, and what was likely one of these individuals was identified nearby in Area A on 18 March 2011 (Cooper 2010a).

The Western Meadowlark is not protected at the state or federal level, but is considered a Los Angeles County Bird Species of Special Concern (Allen et al. 2009). It was present within all areas of the BWER (Figure 8.3) throughout both baseline years, however this species has not been confirmed breeding on site since 2005 (D.S. Cooper, unpublished data).

Unlike the first baseline year (and similar to most prior years), neither the White-tailed Kite (*Elanus Leucurus*) nor the Least Bell's Vireo (*Vireo bellii*) bred or attempted to breed here during the second baseline year, although the Least Bell's Vireo bred in nearby Playa Vista in spring 2011 (D.S. Cooper, unpublished data).

Figure 8.6. Photo of Belding's Savannah Sparrow on 12 May 2010 (photo: D. Cooper).

Two additional species were formerly considered to have special status when nesting, but they are now classified as "WatchList" species by California Dept. of Fish and Game: the Double-crested Cormorant (*Phalacrocorax auritus*) and Cooper's Hawk (*Accipiter cooperii*). Both bred in nearby Marina del Rey (D.S. Cooper, unpublished data) and visited the BWER for foraging during the second baseline year.

ANALYSIS OF BASELINE RESULTS

Overall, both years of baseline surveys yielded similar patterns in terms of species distribution, habitat usage, and species richness. Additionally, consistent seasonal differences over both baseline years were clarified by the BAP.

The fact that similar geospatial patterns between both baseline years were identified for two species with markedly different ecological needs, the Belding's Savannah Sparrow and the Common Yellowthroat, (see above) suggests that the baseline surveys are probably effective in detecting distribution patterns. This may be especially true for the more common species, rather than being mere "snapshots" of variable and unpredictable habitat usage. These data should be useful in identifying key habitat resources by identifying areas with consistent high densities of particular species and species guilds (e.g. grassland species, scrub species).

The baseline monitoring program results suggest that overall species richness at the BWER may be similar in multiple years, yet additional years of data collection will confirm this. Species richness during reserve-wide surveys also remained consistent over both baseline years, with 109 species being identified in the first year compared to 101 species during the second year. However, only 77 of these species were detected both years. For those species seen only during one year, the majority were likely transients [e.g. Nashville Warbler (*Oreothlypis ruficapilla*)]. Eleven of the top 15 most abundant species in October and April reserve-wide surveys during the first baseline year were found to be the same in the second baseline year. The two most abundant species during both baseline years were the House Finch (*Carpodacus mexicanus*) and White-crowned Sparrow (*Zonotrichia leucophrys*), respectively. Species richness numbers may not be overly informative except to recognize that the site is being used consistently by a wide range of species and to identify which are consistently present between years.

Data from both baseline years showed strong seasonal differences between spring and fall. The majority of species had greater abundances in fall surveys than spring surveys [e.g. Western Meadowlark, House Sparrow (*Passer domesticus*), and White-crowned Sparrow], as well as greater total numbers of all species combined. Several notable exceptions (i.e. higher abundances in April) include the Belding's Savannah Sparrow, Song sparrow (*Melospiza Melodia*), and European Starling (*Sturnus vulgaris*). These seasonal variations may be attributed to more fledglings, family groups, and dispersing post-breeding birds occurring during the fall season (i.e. in October) than in spring, prior to breeding.

The highly mobile nature of birds and the high degree of seasonal turnover, especially for rare or declining species, supports the need to continue long-term monitoring. It will also be important to continue to utilize similar protocols to better understand long-term patterns across years and at multiple scales. These results, and additional analyses of data across baseline years, will improve our understanding of the patterns of bird use and movement across the Reserve, and serve to inform restoration planning and management decisions at the BWER.

FUTURE DIRECTIONS

In the third year, the monitoring program will continue to incorporate reserve-wide surveys on a semi-annual basis (October and April) to target the breeding and post-breeding bird communities. The waterbird surveys aimed at documenting year-round bird usage of Ballona Creek will continue on a quarterly basis (i.e. August, October, February, April). Other, targeted special status species surveys will continue as part of the CEQA process with target species to be determined.

APPENDIX G.1

Bird species presence for all survey types during the second Baseline Assessment Program year

			Quarterly Surveys		Waterbird Surveys					Special-status Species Surveys	
Species		Breeding code	Oct	Apr	Dec	Feb	Apr	Jun	Aug	LFCR	CAGN
Allen's Hummingbird	*Selasphorus sasin*		x	x						x	x
American Bittern	*Botarus lentiginosus*									x*	
American Coot	*Fulica americana*			x	x	x				x	
American Crow	*Corvus brachyrhynchos*		x	x	x		x	x		x	x
American Goldfinch	*Spinus tristis*		x	x						x	x
American Kestrel	*Falco sparverius*		x							x	x
American Pipit	*Anthus rubescens*		x		x						
American Wigeon	*Anas americana*		x		x	x				x	
Anna's Hummingbird	*Calypte anna*		x	x						x	x
Ash-throated Flycatcher	*Myiarchus cinerascens*			x							x
Baird's Sandpiper	*Calidris bairdii*						x				
Barn Swallow	*Hirundo rustica*	1a		x			x	x		x	x
Belted Kingfisher	*Megaceryle alcyon*		x				x			x	x
Bewick's Wren	*Thryomanes bewickii*		x								
Black Oystercatcher	*Haematopus bachmani*				x		x	x			
Black Phoebe	*Sayornis nigricans*	1b	x	x	x		x			x	x
Black Turnstone	*Arenaria melanocephala*						x			x	
Black-and-white Warbler	*Mniotilta varia*		x								
Black-bellied Plover	*Pluvialis squatarola*				x	x	x		x	x	
Black-crowned Night-Heron	*Nycticorax nycticorax*	1b		x						x	
Black-headed Grosbeak	*Pheucticus melanocephalus*			x							x
Black-necked Stilt	*Himantopus mexicanus*		x	x		x				x	
Blue-gray Gnatcatcher	*Polioptila caerulea*		x								
Bonaparte's Gull	*Chroicocephalus ridibundus*				x	x	x				
Brandt's Cormorant	*Phalacrocorax penicillatus*					x					
Brewer's Blackbird	*Euphagus cyanocephalus*									x	
Brown Pelican	*Pelecanus occidentalis*				x	x		x	x	x	
Brown-headed Cowbird	*Molothrus ater*		x	x						x	x
Bufflehead	*Bucephala albeola*				x	x	x				
Bullock's Oriole	*Icterus bullockii*			x						x	

			Quarterly Surveys		Waterbird Surveys					Special-status Species Surveys	
Species		Breeding code	Oct	Apr	Dec	Feb	Apr	Jun	Aug	LFCR	CAGN
Burrowing Owl	*Athene cunicularia*		x								
Bushtit	*Psaltriparus minimus*	2	x	x						x	x
California Gnatcatcher	*Polioptila californica*		x								x
California Gull	*Larus californicus*				x	x	x	x	x	x	
California Thrasher	*Toxostoma redivivum*			x							x
California Towhee	*Melozone crissalis*		x	x						x	x
Canada Goose	*Branta canadensis*	1a		x						x	
Caspian Tern	*Hydroprogne caspia*				x		x	x	x	x	
Cassin's Kingbird	*Tyrannus vociferans*		x							x	x
Chipping Sparrow	*Spizella passerina*			x							x
Cinnamon Teal	*Anas cyanoptera*									x	
Cliff Swallow	*Petrochelidon pyrrhonota*			x						x	
Common Raven	*Corvus corax*	1a	x					x		x	x
Common Yellowthroat	*Geothlypis trichas*		x	x						x	x
Cooper's Hawk	*Accipiter cooperii*	1b	x						x	x	x
Dark-eyed Junco ("Oregon")	*Junco hyemalis*		x								
Double-crested Cormorant	*Phalacrocorax auritus*	1b		x	x	x	x	x	x	x	
Downy Woodpecker	*Picoides pubescens*		x								
Dunlin	*Calidris alpina*				x	x				x	
Eared Grebe	*Podiceps nigricollis*				x	x	x				
Elegant Tern	*Thalasseus elegans*						x		x	x	
Eurasian Collared-Dove	*Streptopelia decaocto*			x							x
European Starling	*Sturnus vulgaris*	1b	x	x	x		x			x	x
Forster's Tern	*Sterna forsteri*									x	
Fox Sparrow	*Passerella iliaca*		x								
Gadwall	*Anas strepera*		x	x	x	x	x	x		x	
Glaucous-winged Gull	*Larus glaucescens*				x					x	
Great Blue Heron	*Ardea herodias*	1b	x	x	x	x	x	x	x	x	x
Great Egret	*Ardea alba*	1b		x		x	x		x	x	x
Great Horned Owl	*Bubo virginianus*		x	x							
Greater Yellowlegs	*Tringa melanoleuca*		x							x	
Great-tailed Grackle	*Quiscalus mexicanus*						x			x	
Green Heron	*Butorides virescens*		x						x		
Green-winged Teal	*Anas crecca*		x		x	x				x	

			Quarterly Surveys		Waterbird Surveys					Special-status Species Surveys	
Species		Breeding code	Oct	Apr	Dec	Feb	Apr	Jun	Aug	LFCR	CAGN
Heermann's Gull	*Larus heermanni*				x	x	x		x	x	
Hermit Thrush	*Catharus guttatus*		x								x
Herring Gull	*Larus argentatus*				x	x				x	
Hooded Oriole	*Icterus cucullatus*			x							x
House Finch	*Carpodacus mexicanus*	2	x	x						x	x
House Sparrow	*Passer domesticus*	1b	x	x			x	x	x	x	x
House Wren	*Troglodytes aedon*		x							x	
Killdeer	*Charadrius vociferus*	1a	x	x		x		x		x	
Lazuli Bunting	*Passerina amoena*			x							x
Least Sandpiper	*Calidris minutilla*			x	x	x	x		x	x	
Lesser Goldfinch	*Spinus psaltria*	2		x						x	x
Lesser Scaup	*Aythya affinis*				x	x					
Lincoln's Sparrow	*Melospiza lincolnii*		x	x						x	x
Loggerhead Shrike	*Lanius ludovicianus*		x								
Long-billed Curlew	*Numenius americanus*			x							
Long-billed Dowitcher	*Limnodromus scolopaceus*			x		x	x				
Mallard	*Anas platyrhynchos*	1a	x	x	x	x	x	x	x	x	x
Marbled Godwit	*Limosa fedoa*				x	x	x		x	x	
Marsh Wren	*Cistothorus palustris*		x							x	
Merlin	*Falco columbarius*			x							x
Mourning Dove	*Zenaida macroura*		x	x			x	x		x	
Nashville Warbler	*Orethlypis ruficapilla*			x							x
Northern Flicker	*Colaptes auratus*									x	
Northern Mockingbird	*Mimus polyglottos*	1b	x	x						x	x
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	1a		x			x	x		x	
Northern Shoveler	*Anas clypeata*				x					x	
Nuttall's Woodpecker	*Picoides nuttallii*		x							x	
Orange-crowned Warbler	*Oreothlypis celata*		x	x						x	x
Osprey	*Pandion haliaetus*				x				x		
Pacific-slope Flycatcher	*Empidonax difficilis*			x							
Palm Warbler	*Setophaga palmarum*		x								
Peregrine Falcon	*Falco peregrinus*		x		x						
Pied-billed Grebe	*Podilymbus podiceps*				x				x	x	
Purple Martin	*Progne subis*										x

Species		Breeding code	Quarterly Surveys		Waterbird Surveys					Special-status Species Surveys	
			Oct	Apr	Dec	Feb	Apr	Jun	Aug	LFCR	CAGN
Red-breasted Merganser	*Mergus serrator*				x	x				x	
Red-shouldered Hawk	*Buteo lineatus*									x	
Red-tailed Hawk	*Buteo jamaicensis*	2	x	x					x	x	x
Red-winged Blackbird	*Agelaius phoeniceus*		x	x				x		x	x
Ring-billed Gull	*Larus delawarensis*				x	x	x			x	
Rock Pigeon	*Columba livia*		x	x	x	x	x	x		x	x
Ruby-crowned Kinglet	*Regulus calendula*		x								
Ruddy Duck	*Oxyura jamaicensis*				x					x	
Ruddy Turnstone	*Arenaria interpres*				x		x			x	
Savannah Sparrow ("Belding's")	*Passerculus sandwichensis beldingi*	1a	x	x			x	x		x	
Savannah Sparrow (other ssp.)	*Passerculus sandwichensis ssp.*		x	x							x
Say's Phoebe	*Sayornis saya*		x		x					x	
Semipalmated Plover	*Charadrius semipalmatus*		x		x	x	x			x	
Sharp-shinned Hawk	*Accipiter striatus*			x							x
Snowy Egret	*Egretta thula*	1b	x	x		x	x		x	x	
Solitary Sandpiper	*Tringa solitaria*			x							
Song Sparrow	*Melospiza melodia*	1a	x	x						x	x
Spotted Sandpiper	*Actitis macularius*				x	x	x			x	
Spotted Towhee	*Pipilo maculatus*		x							x	x
Surfbird	*Aphriza virgata*									x	
Swainson's Thrush	*Catharus ustulatus*			x							x
Thayer's Gull	*Larus thayeri*					x					
Tree Swallow	*Tachycineta bicolor*			x						x	
Turkey Vulture	*Cathartes aura*									x	
Vaux's Swift	*Chaetura vauxi*			x							
Vesper Sparrow	*Pooecetes gramineus*		x								
Violet-green Swallow	*Tachycineta thalassina*									x	
Virginia Rail	*Rallus limicola*									x*	
Wandering Tattler	*Tringa incana*						x				
Western Grebe	*Aechmophorus occidentalis*				x	x	x			x	
Western Gull	*Larus occidentalis*				x	x	x	x	x	x	
Western Kingbird	*Tyrannus verticalis*			x							x
Western Meadowlark	*Sturnella neglecta*	2	x	x						x	x

			Quarterly Surveys		Waterbird Surveys					Special-status Species Surveys	
Species		Breeding code	Oct	Apr	Dec	Feb	Apr	Jun	Aug	LFCR	CAGN
Western Sandpiper	*Calidris mauri*				x					x	
Western Scrub-Jay	*Aphelocoma californica*		x	x						x	
Whimbrel	*Numenius phaeopus*			x	x	x	x		x	x	
White-crowned Sparrow	*Zonotrichia leucophrys*		x	x						x	
White-faced Ibis	*Plegadis chihi*		x								
White-tailed Kite	*Elanus leucurus*		x								
White-throated Swift	*Aeronautes saxatalis*		x	x						x	
Willet	*Tringa semipalmata*				x	x	x		x	x	
Wilson's Snipe	*Gallinago delicata*		x	x							
Wilson's Warbler	*Cardellina pusilla*			x							x
Wrentit	*Chamaea fasciata*		x	x							x
Yellow Warbler	*Setophaga petechia*			x						x	x
Yellow-rumped (Audubon) Warbler	*Setophaga coronata ssp. auduboni*		x	x	x					x	x
Yellow-rumped (Myrtle) Warbler	*Setophaga coronata ssp. coronata*			x							x

* = spotted at Ballona Wetlands Freshwater Marsh
LFCR = Light-footed Clapper Rail Special-status Survey
CAGN = California Gnatcatcher Special-status Survey

Breeding status categories.

CATEGORY	DESCRIPTION
Category 1a	Nesting confirmed (active nest or presence of dependent young incapable of sustained flight/movement) at the BWER/lower Ballona Creek
Category 1b	Breeding activity observed during survey, but actual nesting was adjacent to BWER/lower Ballona Creek (e.g. Ballona Freshwater Marsh).
Category 2	Potential breeding activity observed at BWER/lower Ballona Creek during survey; e.g., paired and/or territorial birds during breeding season in suitable habitat, or family groups (including young capable of flight) appearing mid-season.
Category 3	Sporadic occurrence of adult birds during breeding season, but with no direct evidence of breeding on or adjacent to site. This category is reserved for species known to breed in region, and not for over-summering, obviously non-breeding individuals (including certain waterfowl, shorebirds) that might linger or pass through during spring/summer.

APPENDIX G.2

Special status bird species with the potential to inhabit the Ballona Wetlands Ecological Reserve

Year 1	Year 2	Common Name	Scientific Name	Status
		American Bittern	*Botaurus lentiginosus*	LAC
S	S	Belding's Savannah Sparrow	*Passerculus sandwichensis beldingi*	SE
	P	Belted Kingfisher	*Megaceryle alcyon*	LAC (if nesting)
P	P	Black Oystercatcher	*Haematopus bachmani*	BCC (if nesting)
P	P	Brown Pelican	*Pelecanus occidentalis*	FP (if nesting)
	S	California Gnatcatcher	*Polioptila californica*	FE/CSC
P	P	California Gull	*Larus californicus*	WL (if nesting)
S		California Least Tern	*Sternula antillarum browni*	FE/SE (if nesting)
P	P	Caspian Tern	*Hydroprogne caspia*	BCC/LAC (if nesting)
S	S	Cooper's Hawk	*Accipiter cooperii*	WL (if nesting)
S	S	Double-crested Cormorant	*Phalacrocorax auritus*	WL (if nesting)
P	P	Elegant Tern	*Thalasseus elegans*	WL (if nesting)
		Ferruginous Hawk	*Buteo regalis*	WL/LAC (if wintering)
P		Grasshopper Sparrow	*Ammodramus savannarum*	CSC (if nesting)
		Gray Flycatcher	*Empidonax wrightii*	LAC (if breeding)
		Horned Lark	*Eremophila alpestris*	WL/ LAC
S		Least Bell's Vireo	*Vireo bellii pusillus*	FE/SE
		Least Bittern	*Ixobrychus exilis*	CSC (if nesting)
		Lesser Nighthawk	*Chordeiles acutipennis*	LAC
	P	Lincoln's Sparrow	*Melospiza lincolnii*	LAC (if nesting)
P	P	Loggerhead Shrike	*Lanius ludovicianus*	BCC/ CSC (if nesting)
P	P	Long-billed Curlew	*Numenius americanus*	WL/ BCC (if nesting)
S	S	Merlin	*Falco columbarius*	WL (if wintering)
P		Northern Harrier	*Circus cyaneus*	CSC
	P	Osprey	*Pandion haliaetus*	WL (if nesting)
P	P	Peregrine Falcon	*Falco peregrinus*	FP (if nesting)
		Royal tern	*Thalasseus maximus*	LAC (if breeding)
P	P	Sharp-shinned Hawk	*Accipiter striatus*	WL (if nesting)
		Short-eared Owl	*Asio flammeus*	CSC (if nesting)
P		Sora	*Porzana carolina*	LAC (if breeding)
		Southwestern Willow Flycatcher	*Empidonax traillii extimus*	FE, SE
P	P	Swainson's Thrush	*Catharus ustulatus*	LAC (if nesting)
		Turkey Vulture	*Cathartes aura*	LAC (if nesting)
P	P	Vaux's Swift	*Chaetura vauxi*	CSC (if nesting)
P		Vermilion Flycatcher	*Pyrocephalus rubinus*	CSC (if nesting)
S	S	Vesper Sparrow	*Pooecetes gramineus*	LAC

Year 1	Year 2	Common Name	Scientific Name	Status
S		Western Burrowing Owl	*Athene cunicularia hypugaea*	CSC (if burrowing)
S	S	Western Meadowlark	*Sturnella neglecta*	LAC
		Western Snowy Plover	*Charadrius alexandrinus nivosus*	FT/ CSC (if nesting)
P	P	White-faced Ibis	*Plegadis chihi*	WL/ LAC (if nesting)
S	P	White-tailed Kite	*Elanus leucurus*	FP
P		Willow Flycatcher (other subspecies)	*Empidonax traillii ssp.*	CSC (if nesting)
P	P	Wilson's Warbler	*Cardellina pusilla*	LAC (if nesting)
P	P	Yellow Warbler	*Dendroica petechia*	CSC (if nesting)
P		Yellow-breasted Chat	*Icteria virens*	CSC (if nesting)

	Abbreviation	Status
Federal	FE/FT	Federally Endangered/Federally Threatened
	BCC	Bird Species of Conservation Concern
State	FP	California Fully Protected
	SE/ ST	State Endangered/ State Threatened
	WL	California WatchList (formerly a Species of Special Concern; limited protection)
	CSC	California Bird Species of Special Concern
Local	LAC	Los Angeles County Bird Species of Special Concern

NOTE: "Year 1" and "Year 2" columns indicate presence during the first and second year baseline surveys. 'P' denotes observed species and 'S' denotes observed species exhibiting special status behavior.

NOTE: All bird nomenclature follows current citations from the American Ornithologists' Union's check-list of North American birds (7th Edition, 1998). All special status listings were extracted from the January 2011 California Natural Diversity Database special animals list.

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Photo credit: E. Tuttle

CHAPTER 9:
BENTHIC INVERTEBRATES

Ballona Wetlands Ecological Reserve, Los Angeles, California
Santa Monica Bay Restoration Commission

Prepared for: California State Coastal Conservancy
June 2012

Authors: Elena Del Giudice-Tuttle, Karina Johnston, Charles Piechowski, and Ivan Medel

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BENTHIC INFAUNA AND EPIFAUNA

INTRODUCTION

Benthic invertebrate taxa are useful as ecological indicators; they reflect the state of the environment, especially at the transition from water to land, and can indicate local biodiversity (Hilty and Merenlender 2000). Long-term changes are often assessed by looking at the invertebrate community at higher taxonomic levels or by evaluating the community as a whole (Hodkinson and Jackson 2005). The presence or absence of certain infauna (i.e. burrows into and lives in bottom sediments) or epifauna (i.e. lives on the surface of bottom sediments) within tidal channels can serve as indicators of water quality, anthropogenic stressors to the estuary, and the potential to support other trophic levels (WRP 2006).

The goals of the benthic invertebrate surveys for the Baseline Assessment Program (BAP) included:

1) Determine invertebrate density and distribution of major phyla within the intertidal channels of the Ballona Wetlands Ecological Reserve (BWER);
2) Taxonomically identify invertebrates to species or lowest possible taxa at each survey station benthic invertebrates;
3) Determine the approximate densities of *Cerithidea californica* within the tidal channels of Area B in concordance with Southern California Bight 2008 sampling protocols (Bight 2009).

Species names are cited using current Southern California Association of Marine Invertebrate Taxonomists (SCAMIT) nomenclature (Cadien and Lovell 2011). As invertebrate common names are highly variable or not established for each species, only the scientific names are presented for the purposes of this report.

METHODS – INFAUNA

Site Locations and Times

Infaunal benthic invertebrate sampling was conducted semi-annually (fall and spring) during 2010-2011 at seven stations: two in Area A (BW1 and BW2) and five in Area B (BW4, BW5, BW6, BW7, and BW8) (Figure 9.1). Station locations were the same as the first baseline year.

Fall sampling was conducted on 26 October and 1 November 2010 and will henceforth be referred to collectively as the October sampling. Spring sampling was conducted on 26 and 27 April 2011 and will henceforth be referred to collectively as the April sampling. Each of the seven stations was surveyed once during each sampling event.

The sampling on 26 October 2010 was preceded by rainfall totaling 1.07 cm in the seven days prior to sampling. A total of 3.96 cm of precipitation fell during the month of October, with the majority falling in the first week of the month. Between the sampling on 26 October 2010 and 1 November 2010, only the data for 26-30 October were available on NOAA, with precipitation totaling 0.61 cm. Precipitation during October 2010 exceeded the average monthly rainfall (defined as between the years of 1944 and 2011). Sampling on 26 and 27 April 2011 was preceded by no rain in the week prior to sampling. According to NOAA, the December precipitation total was higher in 2010 than in any previously recorded year at the LAX weather station (NOAA, accessed May 2012) (Figure 9.2).

Figure 9.1. BAP benthic invertebrate sampling stations. Yellow bars represent the flap gate (A) and tide gate (B) locations, respectively. BW1 and BW2 are in the Fiji Ditch of Area A.

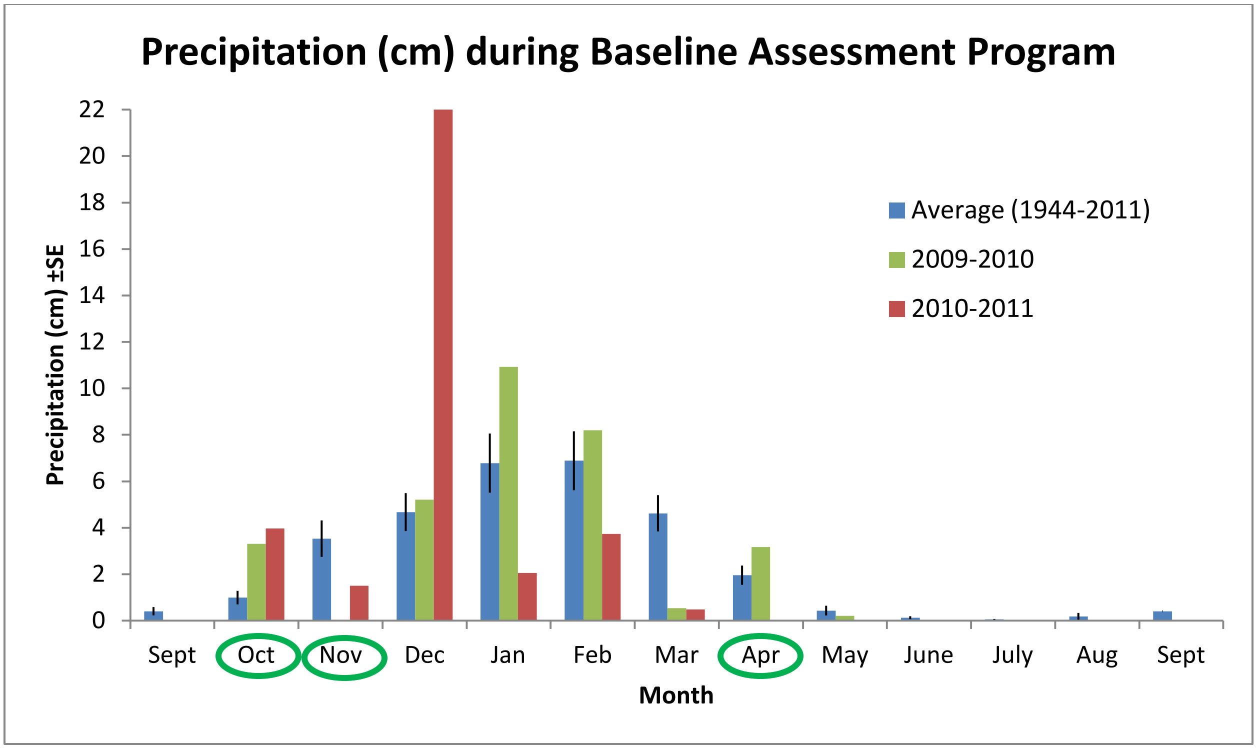

Figure 9.2. Total monthly precipitation (cm) from the first year of the BAP, and the monthly average precipitation (cm) for the Los Angeles International Airport (LAX). Months during which sampling occurred are circled in green (http://www.cnrfc.noaa.gov/monthly_precip_2011.php : accessed May 2012)

Field Methods

Field methods for the second year of benthic invertebrate surveys were identical to the first baseline year. For detailed methods, refer to Chapter 9 of the Baseline Assessment Program: 2009-2010 Report (Johnston et al. 2011). Small cores were taken from the right, left, and thalweg at all stations. Large cores were taken from the right, left, and thalweg only at stations BW1, BW4, BW5, and BW7, not BW2, BW6 or BW8. The reduction in stations was due to little or no data gained from the large cores at stations BW2, BW6, and BW8.

Laboratory and Analysis Methods

Initial laboratory processing and preservation methods for the second year of benthic invertebrate surveys were identical to the first baseline year. For detailed methods, refer to Chapter 9 of the Baseline Assessment Program: 2009-2010 Report (Johnston et al. 2011).

The April samples were subsequently processed by Dancing Coyote Environmental (DCE) who sorted, counted, and identified all individuals to the lowest taxonomic level practicable. 'Practicable' was dictated by the extreme taxonomic difficulty of certain groups (e.g. Oligochaetes), juveniles, or damaged specimens (L. Lovell, pers. comm. 2012). Additionally, one to five individuals of each species were placed in a catalogued voucher collection, when possible. The October samples were sorted and analyzed using preliminary processing methods only and are therefore not included in the species-level results. Vouchers from the October samples were sent to DCE for verifications and will be included in subsequent reports.

The April data were analyzed to determine the taxonomic composition and density of the benthic infaunal community, which was recorded as the number of individuals per square meter for each station. Taxonomic composition refers to the lowest practicable taxon identified. Data for each station were analyzed separately for both large and small cores. Each type of core (i.e. small or large) consisted of combined data from the whole station (i.e. left, right, and thalweg samples combined). For consistency with previous Ballona reports (e.g. Chambers 1996, 1999, MEC 2005, Dorsey 2007), each stations' results were analyzed as density of organisms / m^2. Each station consisted of a total area (combining right, left, and thalweg) of 0.023562 m^2 for the large cores and 0.02544 m^2 for the small cores.

METHODS – EPIFAUNA

Field methods for the second year of epifaunal invertebrate surveys were identical to the first baseline year with the permanent addition of Transect 4, previously added for only the later surveys in the first baseline year. For detailed methods, refer to Chapter 9 of the Baseline Assessment Program: 2009-2010 Report (Johnston et al. 2011; Bight 2009).

Laboratory and Analysis Methods

There are no laboratory methods for these sampling events as counts were conducted *in situ*. Analyses were completed by determining the average number of *C. californica* / m^2 (± standard error) along each transect and comparing densities between transects and survey months.

RESULTS

Infauna Results

All species-level results are from the April 2011 surveys. Forty-two taxa were identified in small and large cores in April of the second baseline assessment year. Appendix H.1 presents presence data for all stations and taxonomic identifications. *Monocorophium insidiosum, Grandidierella japonica, Capitella capitata* Cmplx, *Acteocina inculta,* Oligochaeta*,* and *Streblospio benedicti* were the most common species found in order of greatest to lowest density of individuals / m^2. The qualifier "Cmplx" of *Capitella capitata* is used to denote a group of several sibling species (or subspecies) because of the extreme morphological similarity of the genus locally. It was shown by Grassle & Grassle (1976) with electrophoresis (early genetic/molecular technique) that there were 10 sibling species on the US east coast at the time. Since they behave similarly in terms of pollution tolerance and feeding mode, local taxonomists do not separate them.

A total of 9,064 individuals were processed in the second year April benthic invertebrate samples. Oligochaeta, *M. insidiosum,* and *A. inculta* were present at all stations (Appendix H.1). The same species, with the addition of *Polydora nuchalis* and *C. capitata* Cmplx were also present at all stations in the most recent surveys conducted by MEC Weston (USACE 1135) (Appendix H.2).

Large Core Results

The phylum with the highest total percentage of organisms in the large samples was Mollusca. Five species from three phyla accounted for 69.4% of the density of organisms for the large samples (Table 9.1). Table 9.1 lists species that accounted for greater than 4% of the total large core density. There were a total of 20 species identified in the large cores across all stations surveyed. *A. inculta* accounted for 30.6% of the total average density of organisms across stations for large samples (Table 9.1). *Cirriformia sp.* and *M. insidiosum* accounted for the next highest percentages of the large samples (18.4% and 10.2% respectively).

Table 9.1. Average densities and percent of total large core invertebrates for the five most prevalent species within the large cores.

Phylum	**Class**	**Order**	**Family**	**Species**	**Average Density**	**Percent of Total**
Mollusca	Gastropoda	Opisthobranchia	Cylichnidae	*Acteocina inculta*	**127.3**	**30.6**
Annelida	Polychaeta	Canalipalpata	Cirratulidae	*Cirriformia sp*	**76.4**	**18.4**
Arthropoda	Malacostraca	Amphipoda	Corophiidae	*Monocorophium insidiosum*	**42.4**	**10.2**
Mollusca	Pelecypoda	Venerida	Solenidae	*Solen rostriformis*	**25.5**	**6.1**
Mollusca	Pelecypoda	Venerida	Veneridae	*Venerupis phillipinarum*	**17.0**	**4.1**

BW4 had the highest average density of organisms for the large core samples (806.4 individuals / m^2); BW1 had the lowest average density of organisms for the large core samples (84.9 individuals / m^2) (Figure 9.3). Note that Stations BW2, BW6, and BW8 were not sampled with large cores.

Samples were further analyzed by determining the proportion of the total sample (the left, right, and thalweg cores combined) belonging to each phyla (Figure 9.3 and 9.4). Phyla represented in the large cores were Nemertea, Mollusca, Annelida, Cnidaria, and Arthropoda. All stations contained organisms from the phyla Mollusca. All but BW5 contained Annelida, and all but BW1 contained Arthropoda. Only BW7 contained organisms from Cnidaria, and only BW4 contained organisms from Nemertea. Organisms from the phylum Mollusca and Annelida accounted for the largest percentage of organisms in each of the samples from BW1 (50% and 50%, respectively), BW4 (42% and 37%, respectively), and BW7 (27% and 45%, respectively) (Figure 9.4). BW5 did not contain organisms from the phylum Annelida (29% Arthropoda and 71% Mollusca).

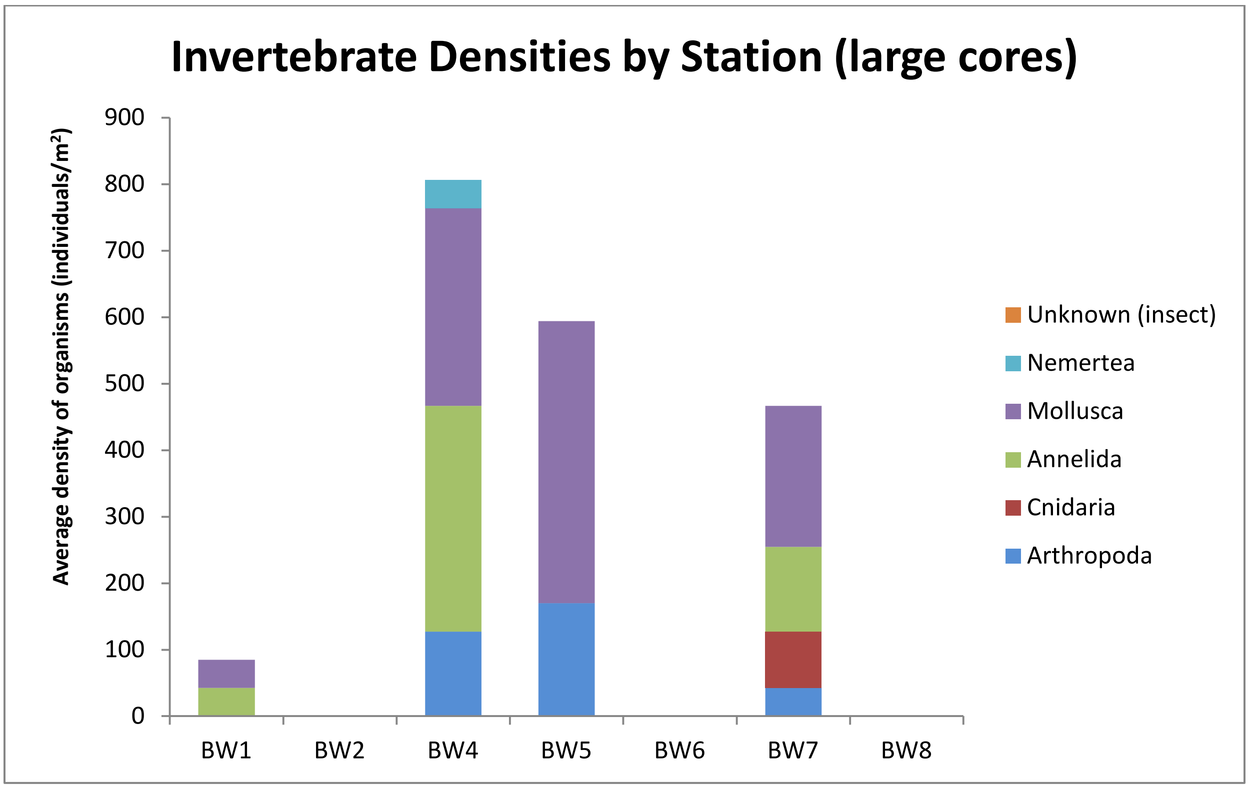

Figure 9.3. Average density of organisms(#individuals/m^2) by station for large cores.

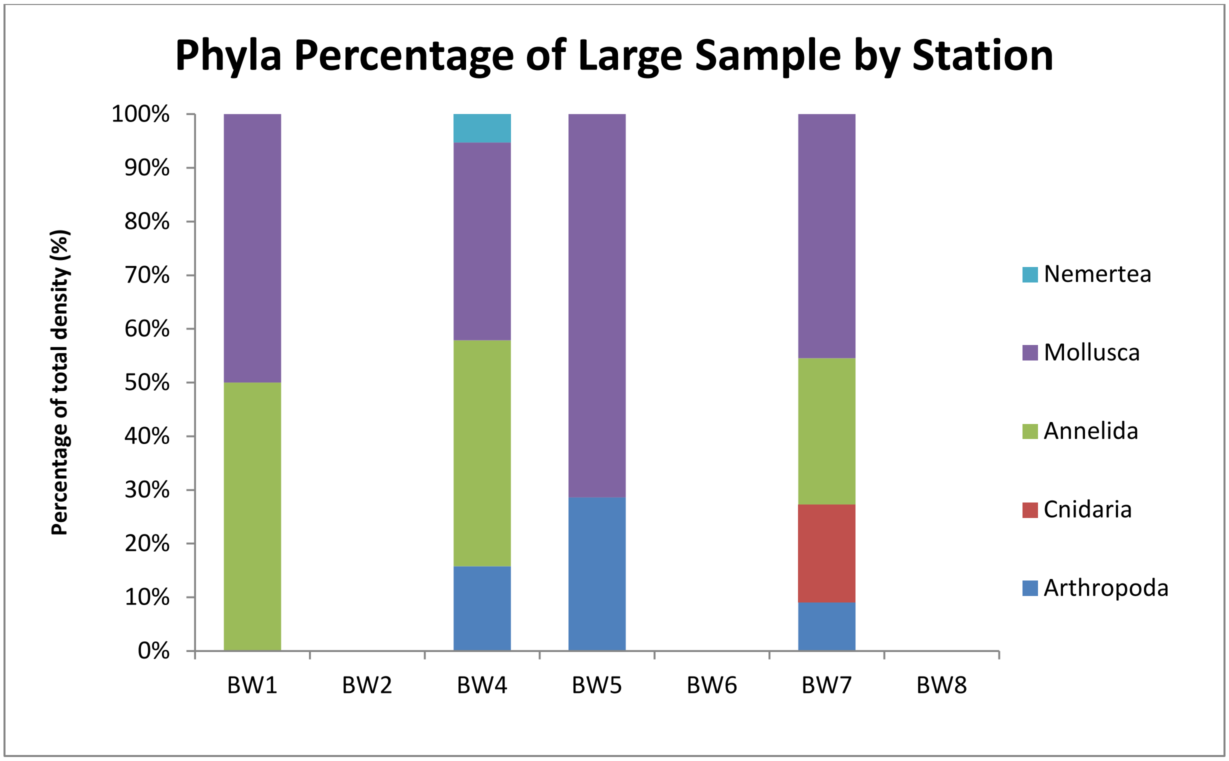

Figure 9.4. Percentage of each phyla at each station for large samples. Data were combined for three sides of channel.

Small Core Results

The phylum Arthropoda had the highest percentage of organisms in the small cores. Seven species from three phyla accounted for 93.3% of the density of organisms for the small samples (Table 9.2). Table 9.2 lists species that accounted for greater than 4% of the total small core density. There were a total of 36 species identified in the small cores across all stations surveyed. *M. insidiosum* accounted for 48.3% of the total average density of organisms across all small core stations. *G. japonica* and *C. capitata* Cmplx accounted for the next highest percentage of the small samples (15.1% and 7.5%, respectively).

Table 9.2. Average densities and percent of total small core invertebrates for species accounting for more than 4% of total density of organisms within the small cores.

Phylum	Class	Order	Family	Species	Average Density	Percent of Total
Arthropoda	Malacostraca	Amphipoda	Corophiidae	*Monocorophium insidiosum*	**26,510.6**	**48.3**
Arthropoda	Malacostraca	Amphipoda	Aoridae	*Grandidierella japonica*	**8277.2**	**15.1**
Annelida	Polychaeta	----	Capitellidae	*Capitella capitata* Cmplx	**4127.4**	**7.5**
Mollusca	Gastropoda	Opisthobranchia	Cylichnidae	*Acteocina inculta*	**3638.8**	**6.63**
Arthropoda	Malacostraca	Amphipoda	Hyalellidae	*Allorchestes angusta*	**3464.7**	**6.32**
Annelida	Oligochaeta	----	----	Oligochaeta	**2717.9**	**4.9**
Annelida	Polychaeta	Canalipalpata	Spionidae	*Streblospio benedicti*	**2425.9**	**4.4**

The small cores had an average density of organisms of 54,862.9 individuals / m^2. BW6 (75,471.7 individuals / m^2) and BW4 (73545.6 individuals / m^2) had the highest average density of organisms for the small core samples (Figure 9.5). BW5 had the lowest average density of organisms (25,078.6 individuals / m^2), approximately one third of the average density of each of the two highest average density stations, BW6 and BW4. BW2 and BW7 had similar average densities of organisms closest to the small core average (54,874.21 individuals / m^2 and 54,638.36 individuals / m^2 respectively).

Phyla represented in the small cores were Mollusca, Annelida, Nemertea, Cnidaria, Arthropoda, (Figure 9.8) and one unknown organism, likely an insect larva. All stations contained organisms from Arthropoda and Annelida (Figure 9.8). BW8 was the only station in which Mollusca was absent. BW6, BW7, and BW8 contained organisms from the phyla Cnidaria. Nemertea accounted for 0.2% of the small cores. Arthropoda was the dominant phyla for all stations except BW5: BW1 (81%), BW2 (70%), BW4 (73%), BW6 (88%), BW7 (49%), and BW8 (80%) (Figure 9.6). BW5 had 50% organisms from Annelida. Annelida accounted for the second highest percentage at most stations: BW2 (21%), BW4 (26%), BW6 (7%), BW7 (28%), and BW8 (14%).

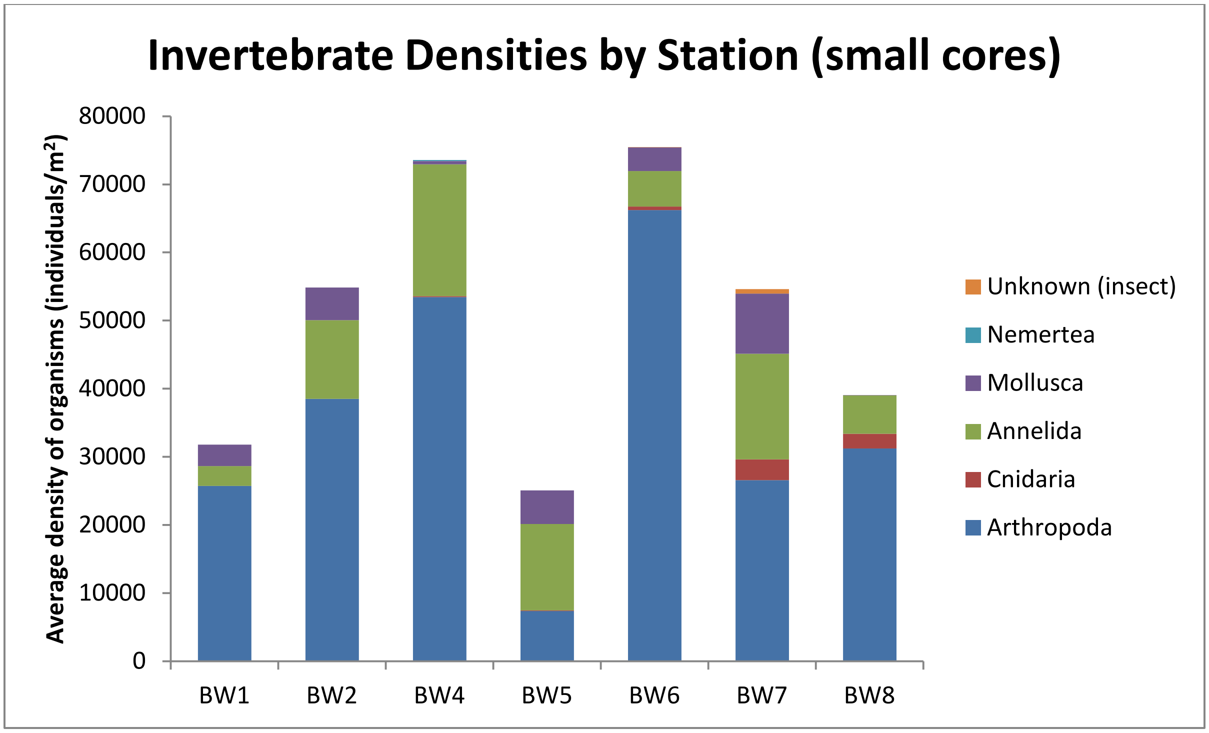

Figure 9.5. Average density of organisms by station for small cores.

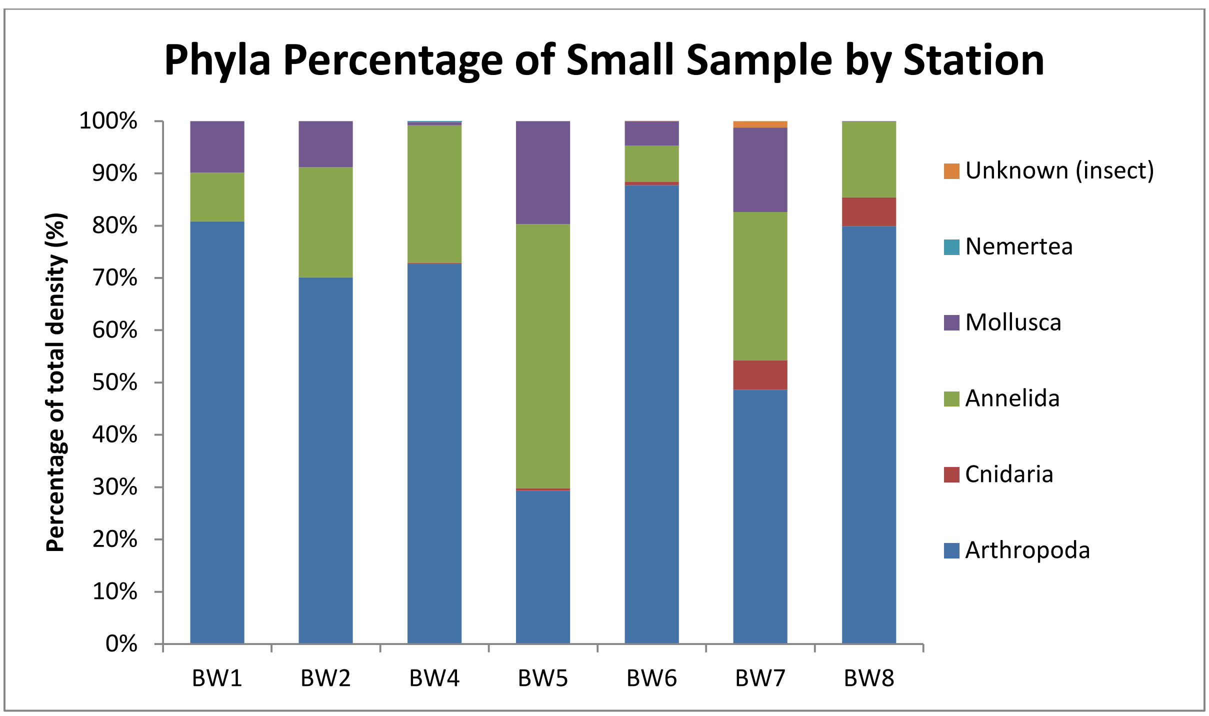

Figure 9.6. Percentage of each phyla of organisms at each station for small samples. Data were combined for three sides of channel.

Epifauna Results

Transect 4 had the highest average number of *C. californica* in all sampling months: January (1021.6 individuals / m^2), March (1546.4 individuals / m^2), June (1474.4 individuals / m^2), and September (864.8 individuals / m^2) (Table 9.3 and Figure 9.7). Transect 2 had the lowest average number of *C. californica* in January (9.6 individuals / m^2), June (12.8 individuals / m^2), and September (10.4 individuals / m^2). Transect 3 had the lowest average number of *C. californica* in March (33.6 individuals / m^2).

The average number of *C. californica* across all transects was lower in winter and fall (January 267.2 individuals / m^2 and September 239.0 individuals / m^2) than in spring and summer (March 422.8 individuals / m^2 and June 387.0 individuals / m^2) (Figure 9.12). The average number of *C. californica* was found to be highest in the March survey on all transects except Transect 3 which recorded a higher number during September (58.4 individuals / m^2) (Figure 9.7).

Table 9.3. Average number of *C. californica* ± standard error (SE) for all transects, separated by sampling period.

Transect	Average Number / m²	Standard Error
Transect 1	24.0	2.92
Transect 2	9.6	0.81
Transect 3	13.6	1.57
Transect 4	1021.6	245.18
January 2011 (average)	267.2	61.55
Transect 1	68.0	5.33
Transect 2	43.2	2.80
Transect 3	33.6	3.70
Transect 4	1546.4	187.07
March 2011 (average)	422.8	56.83
Transect 1	19.2	2.15
Transect 2	12.8	1.02
Transect 3	41.6	4.63
Transect 4	1474.4	80.18
June 2011 (average)	387.0	40.46
Transect 1	22.4	1.69
Transect 2	10.4	0.40
Transect 3	58.4	3.71
Transect 4	864.8	57.47
September 2011 (average)	239.0	24.60
Grand Mean	329.0	33.51

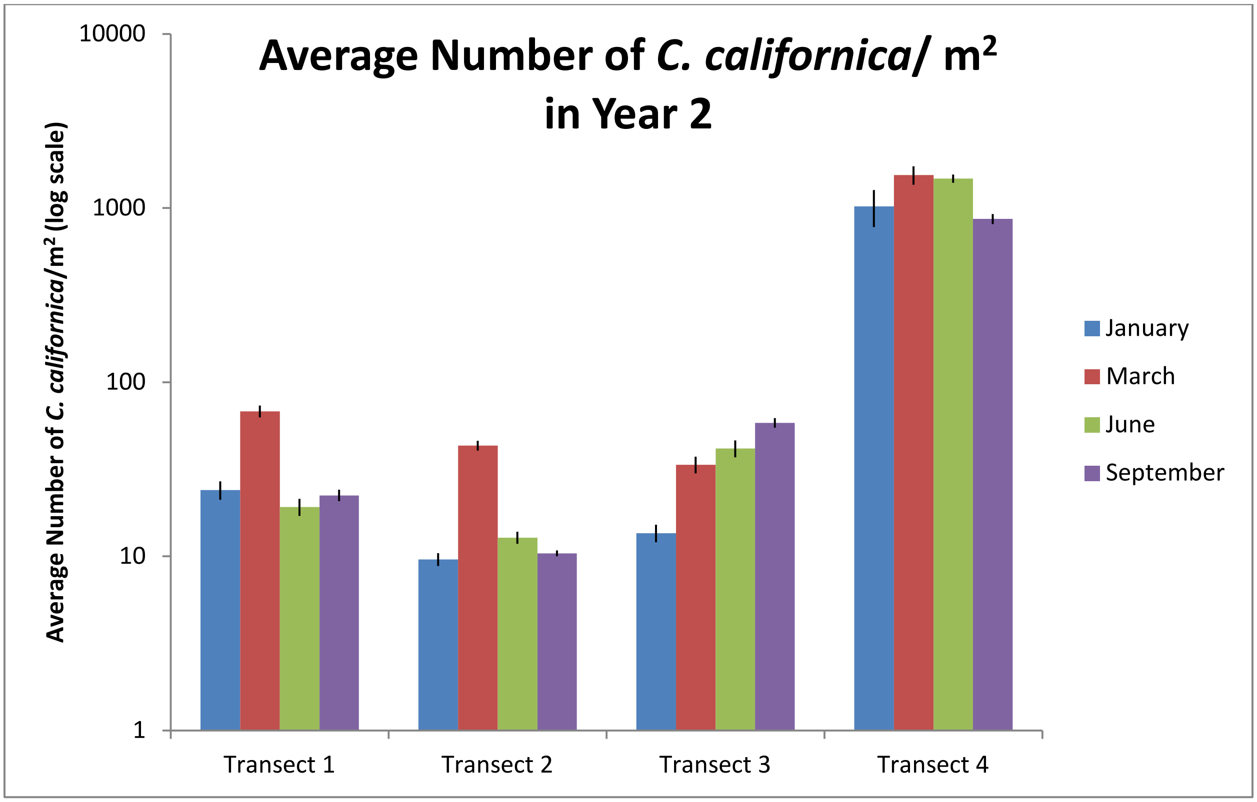

Figure 9.7. Comparison of the average number of *C. californica* ± SE for all transects by month. Note: logarithmic scale on the y-axis.

Epifauna Results across both Baseline Years

For data comparison between both baseline years, only data from Transects 1, 2, and 3 from the sampling in June and September were considered. Average number of *C. californica* was roughly three times higher in 2010 (June and September combined) at Transect 1 (86.8 individuals / m^2) and Transect 2 (55.6 individuals / m^2), whereas Transect 3 had a slightly higher average number of *C. californica* in 2011 (43.6 individuals / m^2) (Figure 9.8).

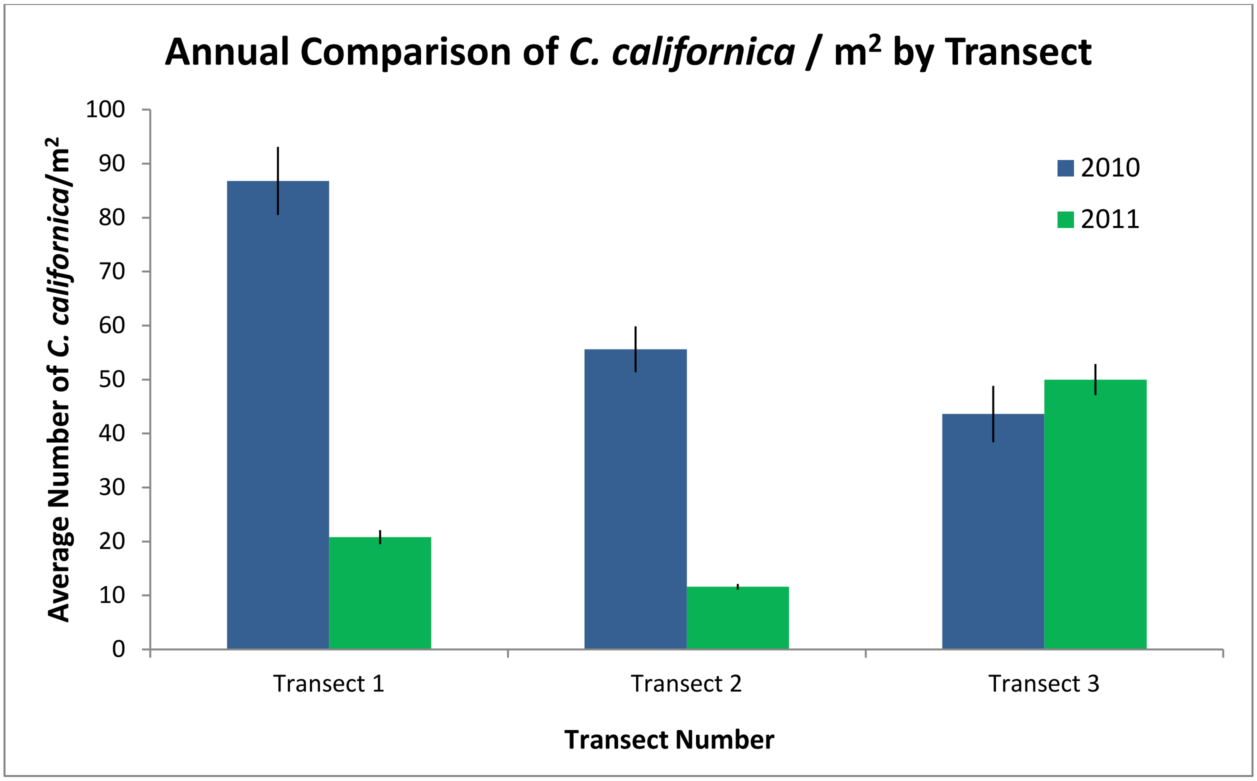

Figure 9.8. Annual comparison between baseline years of the average number of *C. californica* / m^2 on Transects 1, 2, and 3 for June and September combined.

The average number of *C. californica* across transects in June 2010 was fairly uniform, whereas it was more variable in September of the same sampling year (Figure 9.9). All transects had higher average numbers of *C. californica* in the first baseline year in both June and September, except at Transect 3 in September, which was also the lowest average for all transects and both years. Transect 1 in September 2010 had the highest average number of *C. californica* for all transects and both years.

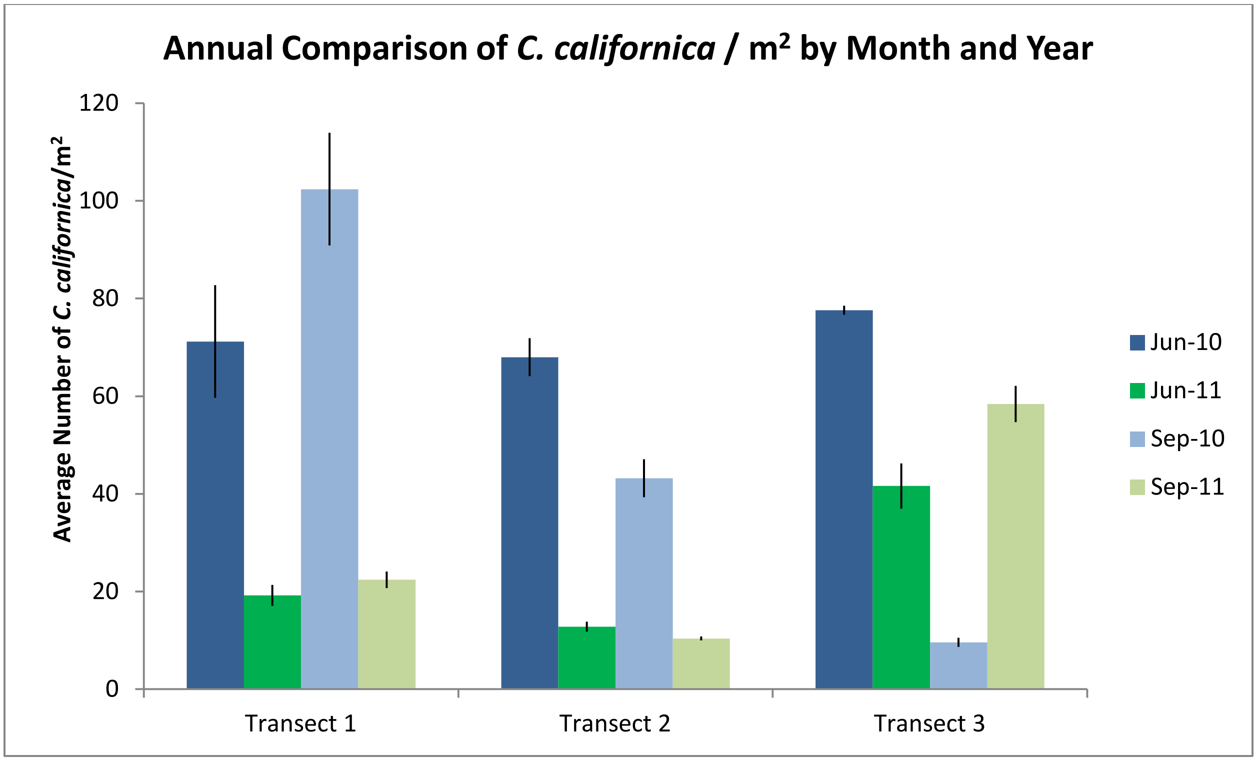

Figure 9.9. Comparison between baseline years of the average number of *C. californica* / m^2 on Transects 1, 2, and 3 in June and September 2010 and 2011.

Special Status Species

Targeted surveys for *Tryonia imitator* were not conducted during the second year of the BAP. No species of special concern were observed visually at the sampling stations nor were they found in any of the samples.

ANALYSIS OF BASELINE RESULTS

Infauna

Both the first and second year baseline survey samples were analyzed for average density of organisms (individuals / m^2). Average organism densities and group (phyla) proportions differed between large and small cores; therefore, small and large cores continued to be analyzed separately.

Refinement of sorting and reporting categories for benthic sample results was made possible by sending samples to qualified taxonomists. Although similar phyla were represented in both baseline years, differences in percentages and densities were detected. The first baseline year data were reported by general groups (Mussels, clams, gastropods, worms, amphipods, *C. californica*) whereas the second year data allowed grouping by Phyla roughly comparable to the first year. The phylum Mollusca was mostly dominant in both baseline years, although sorting procedures and categories were slightly different. First baseline year results were weighted by high numbers of *C. californica* due to inconsistencies in identification of live specimens (e.g. intact operculum). Bivalve species' presence counts and densities differed slightly between the first and second baseline years due to different criteria for inclusion (e.g. considerations such as 'live' or not). The taxonomists processing the second year baseline samples counted only those bivalves and gastropods whole and live at time of collection. Additionally, low 'worm' numbers in the first baseline year were most likely due to difficulty of identification and sorting. The general categorization of 'worms' was necessitated by the poor condition post-processing of minute soft bodied organisms, most likely due to osmotic shock caused by rinsing in freshwater. Additional field rinsing precautions in the second baseline year (and continuing in to the third year) facilitated more detailed identification of these taxa. Therefore, the second year results contain more individuals as well as new phyla.

Seasonal effects were identified in the first baseline year. Due to the change in processing methods between the October and April surveys in the second baseline year, seasonal comparison was not possible. Maintaining consistency in the core volumes and sieve sizes, as well as the continuation of consistent processing and identification methods, will enable seasonal comparison in the following monitoring year.

The addition of species-level data in the second baseline year enabled further analysis of species composition and distribution. Identification to lowest possible taxon will continue in the third baseline year and will allow species-level comparison and analysis. Preliminary analysis of species-level data indicate differences in density, composition, and distribution between inter- and intra- channel locations. Additional years of sampling utilizing consistent methods may allow evaluation of the effects of the hydrology and geomorphology of the BWER channels (e.g. effects of tide gates, tidal flow, channel morphology, and freshwater inputs) on the benthic invertebrate community.

Epifauna

Although average densities of *C. californica* showed distinct seasonal trends in the first baseline year these patterns were not evident in the second baseline year. Neither the transect-level averages nor the seasonal averages maintained the discernible patterns from the first year to the second baseline year. The first baseline year did show a higher average density than the second baseline year when averaging June and September on Transects 1, 2, and 3 (Figure 9.8).

Transect 4 showed consistently higher average densities across all months in the second baseline year. Inclusion of Transect 4 in the epifaunal surveys will continue, as this transect appears to represent an area with a slightly different (higher) density of *C. californica*. The increased frequency of epifaunal surveys from semi-annual in the first year to quarterly surveys in the second year will also continue in the third baseline year. Seasonal variability in the average density of *C. californica* in the second baseline year indicates the importance of the maintaining the increased sampling frequency.

FUTURE DIRECTIONS

A voucher collection was started in the second baseline year; it will be added to in future monitoring years to enable accurate and comparable future surveys. Benthic invertebrate surveys will continue using the same spatial and temporal sampling pattern in the third year of monitoring (2012-2013) with the same processing methods.

APPENDIX H.1

Benthic invertebrate species from the BAP second baseline year April 2011 survey by station and core size.

Phylum	Class	Order	Family	Species*	BW1		BW2		BW4		BW5		BW6		BW7		BW8	
					Lg	Sm	Lg	Sm	Lg	Sm	Lg	Sm	Lg	Sm	Lg	Sm	Lg	Sm
Annelida	Oligochaeta	----	----	Oligochaeta		X		X		X		X		X		X		X
Annelida	Polychaeta	Aciculata	Eunicidae	*Marphysa sp*		X												
Annelida	Polychaeta	Aciculata	Nereididae	*Neanthes acuminata Cmplx*		X												
Annelida	Polychaeta	Aciculata	Nereididae	*Nereididae*														
Annelida	Polychaeta	Aciculata	Syllidae	*Exogone lourei*		X												
Annelida	Polychaeta	Aciculata	Syllidae	*Exogone sp A*						X		X		X		X		X
Annelida	Polychaeta	Canalipalpata	Cirratulidae	*Cirratulidae*						X								
Annelida	Polychaeta	Canalipalpata	Cirratulidae	*Cirriformia sp*	X				X	X				X				
Annelida	Polychaeta	Canalipalpata	Sabellidae	*Fabricinuda limnicola*						X		X			X			
Annelida	Polychaeta	Canalipalpata	Spionidae	*Polydora nuchalis*		X		X		X					X			X
Annelida	Polychaeta	Canalipalpata	Spionidae	*Spionidae*		X								X		X		X
Annelida	Polychaeta	Canalipalpata	Spionidae	*Streblospio benedicti*				X		X		X		X	X	X		X
Annelida	Polychaeta	----	Capitellidae	*Capitella capitata Cmplx*		X		X		X		X		X		X		X
Annelida	Polychaeta	----	Orbiniidae	*Scoloplos acmeceps*		X												
Arthropoda	Insecta	Diptera	----	fly larvae				X			X							
Arthropoda	Malacostraca	Amphipoda	Ampithoidae	*Ampithoe lacertosa*						X								
Arthropoda	Malacostraca	Amphipoda	Ampithoidae	*Ampithoe plumulosa*						X				X				
Arthropoda	Malacostraca	Amphipoda	Ampithoidae	*Ampithoe sp*						X				X				
Arthropoda	Malacostraca	Amphipoda	Ampithoidae	*Ampithoe valida*						X				X		X		
Arthropoda	Malacostraca	Amphipoda	Aoridae	*Grandidierella japonica*		X		X		X	X	X		X		X		X
Arthropoda	Malacostraca	Amphipoda	Corophiidae	*Monocorophium insidiosum*		X		X	X	X	X	X		X	X	X		X
Arthropoda	Malacostraca	Amphipoda	Corophiidae	*Monocorophium sp*		X		X		X		X		X		X		X

Phylum	Class	Order	Family	Species*	BW1		BW2		BW4		BW5		BW6		BW7		BW8	
					Lg	Sm	Lg	Sm	Lg	Sm	Lg	Sm	Lg	Sm	Lg	Sm	Lg	Sm
Arthropoda	Malacostraca	Amphipoda	Hyalellidae	*Allorchestes angusta*					X	X				X		X		X
Arthropoda	Malacostraca	Amphipoda	Hyalidae	*Protohyale frequens*												X		
Arthropoda	Malacostraca	Isopoda	Sphaeromatidae	*Sphaeromatidae*										X				X
Arthropoda	Ostracoda	Podocopida		*Podocopida*														X
Cnidaria	Anthozoa	Actiniaria	Diadumenidae	*Diadumene sp*						X					X			X
Cnidaria	Anthozoa	Actiniaria	Edwardsiidae	*Drillactis sp*								X		X	X	X		X
Cnidaria	Anthozoa	Actiniaria	----	*Athenaria*						X								
Mollusca	Gastropoda	Opisthobranchia	Aglajidae	*Melanochlamys diomedea*										X				
Mollusca	Gastropoda	Opisthobranchia	Cylichnidae	*Acteocina inculta*		X		X	X	X	X	X		X	X	X		X
Mollusca	Gastropoda	Sorbeoconcha	Potamididae	*Cerithidea californica*							X	X		X				
Mollusca	Pelecypoda	Mytilida	Mytilidae	*Mytilidae, juv*		X												
Mollusca	Pelecypoda	Venerida	Solenidae	*Solen rostriformis*					X									
Mollusca	Pelecypoda	Venerida	Veneridae	*Chione californiensis*	X													
Mollusca	Pelecypoda	Venerida	Veneridae	*Leukoma laciniata*						X				X				
Mollusca	Pelecypoda	Venerida	Veneridae	*Tellina meropsis*					X									
Mollusca	Pelecypoda	Venerida	Veneridae	*Venerupis phillipinarum*					X									
Nemertea	----	Hoplonemertea	Emplectonematidae	*Paranemertes californica*						X								
Nemertea	----	Paleonemertea	Carinomidae	*Carinoma mutabilis*						X								
Nemertea	----	Paleonemertea	----	*Paleonemertea*						X								
Nemertea	----	----	----	Nemertea					X									
Unknown	Unknown	Unknown	Unknown	unknown (insect)										X		X		

Note: * = Species or lowest practicable taxon.

APPENDIX H.2

Benthic invertebrate species present from MEC (2005) and of the second baseline year April 2011 samples of the Ballona Wetlands Ecological Reserve.

Phylum	Class	Order	Family	Species*	MEC	BAP
Annelida	Clitellata	----	----	*Oligochaeta*	X	X
Annelida	Polychaeta	----	Capitellidae	*Capitella capitata Cmplx*	X	X
Annelida	Polychaeta	----	Capitellidae	*Notomastus sp*	X	
Annelida	Polychaeta	----	Capitellidae	*Notomastus sp HYP3*	X	
Annelida	Polychaeta	----	Capitellidae	*Notomastus hemipodus*	X	
Annelida	Polychaeta	----	Orbiniidae	*Scoloplos acmeceps*		X
Annelida	Polychaeta	----	----	*Euclymeninae*	X	
Annelida	Polychaeta	Aciculata	Eunicidae	*Marphysa sp*		X
Annelida	Polychaeta	Aciculata	Nereididae	*Neanthes acuminata Cmplx*		X
Annelida	Polychaeta	Aciculata	Nereididae	*Nereididae*		X
Annelida	Polychaeta	Aciculata	Syllidae	*Exogone lourei*		X
Annelida	Polychaeta	Aciculata	Syllidae	*Exogone sp*	X	X
Annelida	Polychaeta	Canalipalpata	Cirratulidae	*Cirratulidae*		X
Annelida	Polychaeta	Canalipalpata	Cirratulidae	*Cirriformia sp*		X
Annelida	Polychaeta	Canalipalpata	Sabellidae	*Fabricinuda limnicola*	X	X
Annelida	Polychaeta	Canalipalpata	Spionidae	*Polydora nuchalis*	X	X
Annelida	Polychaeta	Canalipalpata	Spionidae	*Spionidae*	X	X
Annelida	Polychaeta	Canalipalpata	Spionidae	*Streblospio benedicti*	X	X
Annelida	Polychaeta	Phyllodocida	Glyceridae	*Hemipodus borealis*	X	
Annelida	Polychaeta	Spionida	Spionidae	*Polydora sp*	X	
Arthropoda	Insecta	Diptera	----	fly larvae		X
Arthropoda	Malacostraca	Amphipoda	Ampithoidae	*Ampithoe lacertosa*		X
Arthropoda	Malacostraca	Amphipoda	Ampithoidae	*Ampithoe plumulosa*		X
Arthropoda	Malacostraca	Amphipoda	Ampithoidae	*Ampithoe sp*		X

Phylum	Class	Order	Family	Species*	MEC	BAP
Arthropoda	Malacostraca	Amphipoda	Ampithoidae	*Ampithoe valida*	**X**	**X**
Arthropoda	Malacostraca	Amphipoda	Aoridae	*Grandidierella japonica*	**X**	**X**
Arthropoda	Malacostraca	Amphipoda	Corophiidae	*Monocorophium insidiosum*	**X**	**X**
Arthropoda	Malacostraca	Amphipoda	Corophiidae	*Monocorophium sp*		**X**
Arthropoda	Malacostraca	Amphipoda	Hyalellidae	*Allorchestes angusta*		**X**
Arthropoda	Malacostraca	Amphipoda	Hyalidae	*Protohyale frequens*		**X**
Arthropoda	Malacostraca	Amphipoda	Pontogeneiidae	*Tethygeneia opata*	**X**	
Arthropoda	Malacostraca	Amphipoda	Corophiidae	*Monocorophium acherusicum*	**X**	
Arthropoda	Malacostraca	Isopoda	Sphaeromatidae	*Dynamenella dilatata*	**X**	
Arthropoda	Malacostraca	Isopoda	Sphaeromatidae	Sphaeromatidae		**X**
Arthropoda	Malacostraca	Tanaidacea	Paratanaoidea incertae sedis	*Tanaopsis cadieni*	**X**	
Arthropoda	Maxillopoda	Poecilostomatoida	Sapphirinidae	*Edwardsia sp*	**X**	
Arthropoda	Ostracoda	Podocopida	----	*Podocopida*		**X**
Cnidaria	*Anthozoa*	----	----	*Anthozoa*	**X**	
Cnidaria	Anthozoa	Actiniaria	Actiniidae	*Anthopleura artemisia*	**X**	
Cnidaria	Anthozoa	Actiniaria	Diadumenidae	*Diadumene sp*		**X**
Cnidaria	Anthozoa	Actiniaria	Edwardsiidae	*Drillactis sp*	**X**	**X**
Cnidaria	Anthozoa	Actiniaria	----	*Athenaria*		**X**
Cnidaria	Anthozoa	Actiniaria	----	*Edwardsiidae*	**X**	
Cnidaria	Hydrozoa	Leptothecata	----	*Campanulariidae*	**X**	
Mollusca	Gastropoda	Cephalaspidea	Clyichnidae	*Acteocina harpa*	**X**	
Mollusca	Gastropoda	Opisthobranchia	Aglajidae	*Melanochlamys diomedea*		**X**
Mollusca	Gastropoda	Opisthobranchia	Cylichnidae	*Acteocina inculta*	**X**	**X**
Mollusca	Gastropoda	Sorbeoconcha	Potamididae	*Cerithidea californica*		**X**
Mollusca	Pelecypoda	Mytilida	Mytilidae	*Adula sp BW1*	**X**	
Mollusca	Pelecypoda	Mytilida	Mytilidae	*Mytilidae, juv*		**X**

Phylum	Class	Order	Family	Species*	MEC	BAP
Mollusca	Pelecypoda	Mytilida	Mytilidae	*Mytilus californianus*	**X**	
Mollusca	Pelecypoda	Tellinidae	Tellina	*Tellina cadieni*	**X**	
Mollusca	Pelecypoda	Venerida	Semelidae	*Theora lubrica*	**X**	
Mollusca	Pelecypoda	Venerida	Tellinidae	*Macoma secta*	**X**	
Mollusca	Pelecypoda	Venerida	Tellinidae	*Macoma nasuta*	**X**	
Mollusca	Pelecypoda	Venerida	Veneridae	*Protothaca staminea*	**X**	
Mollusca	Pelecypoda	Venerida	Solecurtidae	*Tagelus affinis*	**X**	
Mollusca	Pelecypoda	Venerida	Solenidae	*Solen rostriformis*		**X**
Mollusca	Pelecypoda	Venerida	Veneridae	*Chione californiensis*		**X**
Mollusca	Pelecypoda	Venerida	Veneridae	*Leukoma laciniata*		**X**
Mollusca	Pelecypoda	Venerida	Veneridae	*Protothaca laciniata*	**X**	
Mollusca	Pelecypoda	Venerida	Veneridae	*Tellina meropsis*		**X**
Mollusca	Pelecypoda	Venerida	Veneridae	*Venerupis phillipinarum*	**X**	**X**
Nematoda	----	----	----	*Nematoda*	**X**	
Nemertea	----	----	----	*Nemertea*		**X**
Nemertea	----	----	----	*Nemertea*		**X**
Nemertea	Anopla	----	Lineidae	*Lineus sp*	**X**	
Nemertea	Anopla	Paleonemertea	----	*Paleonemertea*	**X**	**X**
Nemertea	Anopla	Paleonemertea	Carinomidae	*Carinoma mutabilis*		**X**
Nemertea	Enopla	Hoplonemertea	Emplectonematidae	*Paranemertes californica*	**X**	**X**
Platyhelminthes	Rhabditophora	Seriata	Monocelididae	*Monocelididae*	**X**	
Sipuncula	----	----	----	*Sipuncula*	**X**	
Unknown	----	----	----	unknown (insect)		**X**

Note: * = Species or lowest practicable taxon.

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Photo credit: D. Cooper

CHAPTER 10:
TERRESTRIAL INVERTEBRATES

Ballona Wetlands Ecological Reserve, Los Angeles, California
Santa Monica Bay Restoration Commission

Prepared for: California State Coastal Conservancy
June 2012

Authors: Karina Johnston, Elena Del Giudice-Tuttle, and Sean Anderson

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TERRESTRIAL INVERTEBRATES

INTRODUCTION

Terrestrial invertebrates are a vital link in wetland food webs and may be considered indicators of the overall health of a system (Zedler 2001). Ecosystem function has been measured by counting and identifying insects to species level to determine biodiversity; however, simpler and more rapid measures that describe functions or rates of productivity may be better indicators of ecosystem health (Anderson 2009). These metrics can often be employed rapidly and cost effectively across habitat types and are useful from a management perspective.

The objective of the Baseline Assessment Program (BAP) invertebrate assessment of the Ballona Wetlands Ecological Reserve (BWER) was to estimate aerial arthropod productivity (as biomass) using length-fresh weight regressions for each habitat and to note observations of special status species.

Taxonomic nomenclature and conservation status for species in this report are from the Integrated Taxonomic Information System (ITIS; http://www.itis.gov/, searched January 2012).

METHODS

Site Locations and Times

Terrestrial invertebrate sampling was conducted in summer 2011, between May and September.

Fifty transects were surveyed, comprised of five randomly chosen vegetation transects within each of ten habitat types: brackish marsh, low salt marsh, mid salt marsh, high salt marsh, salt pan, seasonal wetland, freshwater marsh, upland scrub, upland grassland, and upland dune. Each transect was sampled once during the sampling period (May through September 2011) (Table 10.1). The habitat types surveyed in the second baseline year were also surveyed in the first baseline year with the addition of the freshwater marsh. Three traps were deployed equidistant along 30 m transects, which extended 2.5 meters past the start and end of the 25 meter vegetation transects. Each trap was labeled with the individual transect number, date deployed, and replicate (1, 2, or 3) along the transect.

Table 10.1. Habitat types and the month(s) during which terrestrial invertebrate sampling occurred.

Habitat	**Month**
Brackish Marsh	May, June
Estuarine High Marsh	August, September
Estuarine Low Marsh	August, September
Estuarine Mid Marsh	August, September
Freshwater Marsh	July
Salt Pan	June and September
Seasonal Wetland	May, August, September
Upland Dune	May, June
Upland Grassland	May, June
Upland Scrub	May, June

Field Methods

Field methods for the second year of aerial arthropod invertebrate surveys were identical to the first baseline year. For detailed methods, refer to Chapter 10 of the Baseline Assessment Program: 2009-2010 Report (Johnston et al. 2011). Terrestrial vertebrate pitfall surveys began in the second baseline year, but have not been processed. Pitfall trap methods and data from the second baseline year and the third year of monitoring will be included in next year's report.

Additionally, the Friends of Ballona Wetlands (FBW) conducted walking surveys in July of 2011. Species presence is reported in Results.

Laboratory and Analysis Methods

Processing of the samples followed methods developed by Dr. Sean Anderson, California State University Channel Islands. All individual invertebrates were counted and classed by operationally-defined size classes: <0.5 mm, 0.5-2 mm, 2-5 mm, 5-10 mm, or >10 mm. Size-weight regressions for arthropods allow us to derive fresh weight from measuring the length of trapped individuals.

Aerial arthropod biomass was estimated using the same formulas, techniques, and equations used in the first baseline year (Chapter 10: Terrestrial Invertebrates Baseline Report, Johnston et al. 2011). Biomass proportion, based on the defined size classes, was used to assess relative *captured productivity* as a proportion of size class estimates. Additionally, marsh habitat invertebrate productivity was compared across both baseline years. Marsh habitat transects were surveyed at approximately the same time each year and are appropriate for comparison.

RESULTS

General Results and Overall Trends

Aerial arthropod productivity was based on the average available biomass (milligrams of fresh weight) per square meter per day. Productivity refers to the rate of *captured* aerial arthropod biomass on a particular transect or averaged within a particular habitat type during the time of sampling, and is not an indication of the *active production* of the system or whole habitat. The survey method captures a limited spatial and temporal environment. These results indicate relative productivity for each habitat type based on size class proportions and are weighted by biomass (mg).

The salt pan habitat had the lowest average aerial arthropod productivity (mean ± standard error) at 5.18 ± 2.03 mg/m^2/day (Figure 10.1; Table 10.2). The seasonal wetland had the highest average total aerial arthropod productivity and the highest level of variability between transects at 59.95 ± 23.91 mg/m^2/day. These results suggest that the seasonal wetland and freshwater marsh habitats had higher relative proportions of larger invertebrate size classes during the second baseline year in the seasons they were assessed (see Methods).

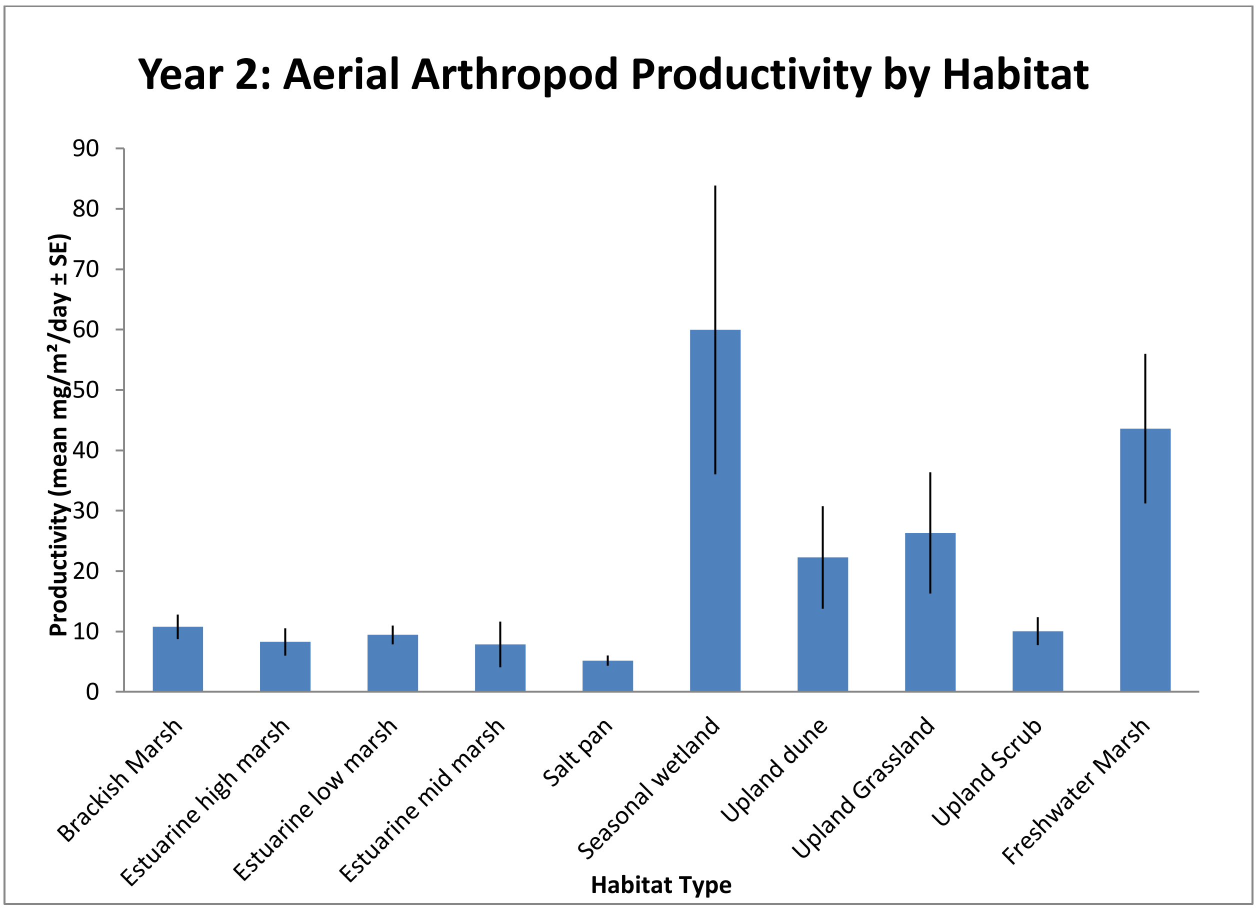

Figure 10.1. Aerial arthropod productivity (mean mg/m²/day ± SE) within each habitat.

Table 10.2. Aerial arthropod productivity (mean mg/m²/day ± SE) within each habitat.

HABITAT	YR2: PRODUCTIVITY (mg/m^2/day)		
	Average productivity	SD	SE
Brackish Marsh	10.77	7.86	2.03
Estuarine high marsh	8.27	8.78	2.27
Estuarine low marsh	9.43	6.01	1.55
Estuarine mid marsh	7.86	14.63	3.78
Salt pan	5.18	3.29	0.85
Seasonal wetland	59.95	92.60	23.91
Upland dune	22.26	32.92	8.50
Upland Grassland	26.33	38.90	10.04
Upland Scrub	10.06	8.97	2.32
Freshwater Marsh	43.60	47.97	12.39

In addition to the aerial arthropod surveys, ancillary observations of the non-native milk snail (*Otala lacteal*) were common throughout the BWER, especially on non-native and upland vegetation. The snail was not surveyed quantitatively but was noted during sampling events.

Marsh Results for both Baseline Years

The low marsh, mid marsh, and high marsh habitats were sampled during the same time periods in both years, so productivity can be compared across years (Figure 10.2). The mid marsh habitat had the highest difference in relative aerial arthropod invertebrate productivity between both baseline years. Both the low and mid marsh habitat types had higher invertebrate productivity in the first baseline year; the high marsh had slightly higher average invertebrate productivity in the second baseline year.

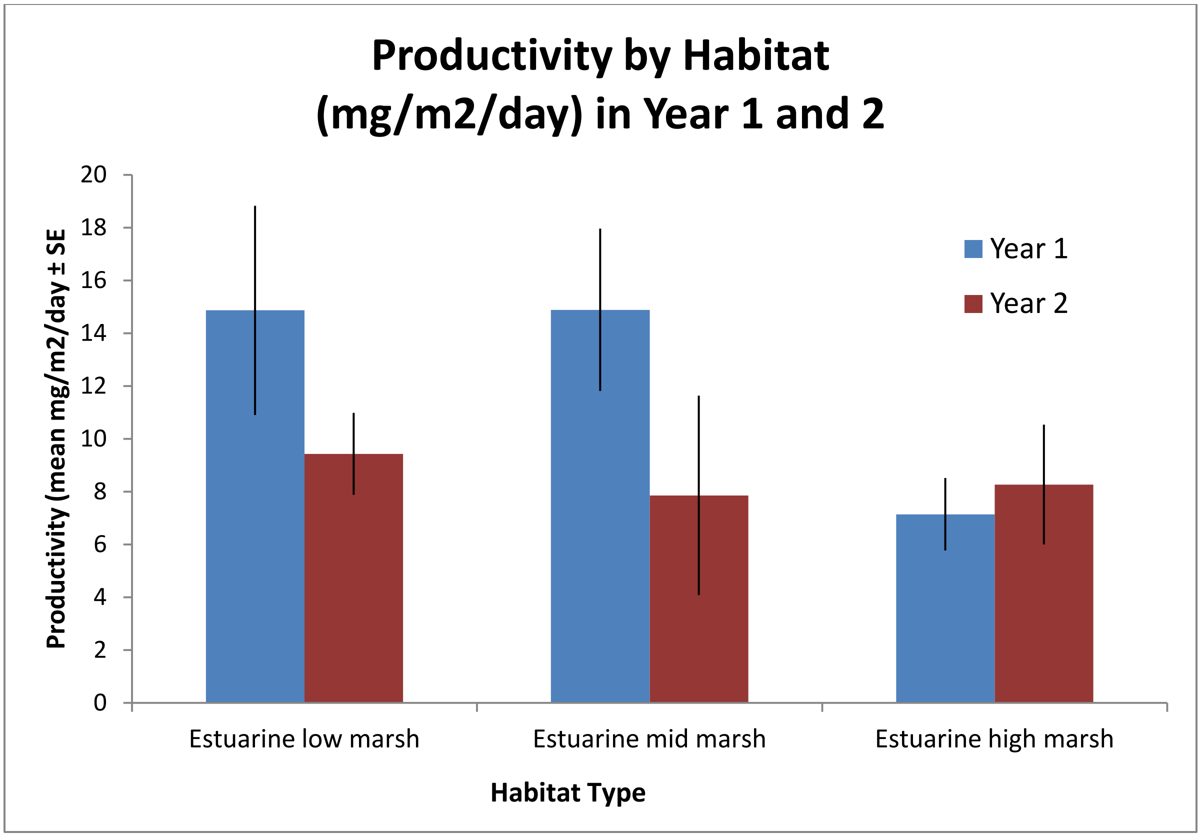

Figure 10.2. Productivity across regions and years at the BWER.

Special Status Species

No special status species were identified in the aerial arthropod surveys; however, species-level taxonomic classifications were not conducted. Ancillary observations of the wandering skipper (*Panoquina errans)* and monarch butterfly (*Danaus plexippus)* were visually confirmed in the marsh habitats of western Area B during vegetation surveys. Appendix I.1 lists special status terrestrial invertebrates with the potential to inhabit the BWER.

Recent walking surveys for butterflies conducted by the Friends of Ballona Wetlands (FBW) found 13 species in 2008, seven species in 2009, 18 species in 2010, and 15 species in 2011 in the salt marsh in the western portion of Area B in July of each year (FBW 2011, unpublished data; Table 10.3); four additional species were found in habitats adjacent to the salt marsh. The FBW recorded the presence of one of the special status butterflies, the wandering skipper.

Approximately 30 individuals of the federally endangered El Segundo Blue Butterfly, *Euphilotes battoides allyni*, were observed on 19 July 2011 while conducting bird surveys (D. Cooper, Cooper Ecological, pers. comm. 2011; Figure 10.3). The individuals were observed in the western dune habitat on dune buckwheat, *Eriogonum parvifolium*, which was planted as part of the Friends of Ballona

Wetlands dune restoration project. The last sighting of the El Segundo blue butterfly in the area was an anecdotal observation in 1986 of one male in Playa Del Rey (Mattoni 1991).

Table 10.3. Butterfly presence from the salt marsh of Area B, riparian, and freshwater marsh habitats (FBW 2011, unpublished data). Note: X* denotes counts from a non-salt marsh habitat type (specified within table).

Common Name	**Species Name**	**2008**	**2009**	**2010**	**2011**
Acmon blue	*Plebejus acmon*	X	X	X	**X* (freshwater)**
American lady	*Vanessa virginiensis*				**X* (freshwater)**
Anise Swallowtail	*Papilio zelicaon*			X	
Blue Sp. (unknown)	----			X	**X**
Cabbage White	*Pieris rapae*	X	X	X	**X**
Checkered White	*Pontia protodice*	X	X	X	
Cloudless Sulphur	*Phoebis sennae*	X			
Common Buckeye	*Junonia coenia*	X		X	**X**
Eufala Skipper	*Lerodea eufala*	X	X	X	**X**
Fiery Skipper	*Hylephila phyleus*	X		X	**X**
Gray Hairstreak	*Srtymon melinus*	X		X	**X**
Lady sp.	----				**X**
Gulf Fritillary	*Argraulis vanillae*			X* (freshwater)	
Marine Blue	*Leptotes marina*	X	X	X	**X**
Monarch	*Danaus plexippus*				**X*(freshwater)**
Mourning Cloak	*Nymphalis antiopa*			X*(riparian)	**X*(freshwater)**
Orange sulphur	*Colias euytheme*	X			
Queen	*Danaus gilippus*	X			
Red admiral	*Vanessa atalanta*				**X**
Sachem Skipper	*Atalopedes campestris*			X	
Sandhill skipper	*Polites sabuleti*			X	**X**
Skipper sp.	----		X	X	**X**
Umber skipper	*Poanes melane*	X		X	**X**
Wandering skipper	*Panoquina errans*			X	**X**
West coast lady	*Vanessa anabella*			X	
Western pygmy-blue	*Brephidium exilis*	X	X	X	**X**
Western swallowtail	*Papilio rutulus*			X* (riparian, cabora, freshwater, triangle)	**X**
White checkered skipper	*Pyrgus albescens*			X* (freshwater)	
White sp.	----			X	
Red = Non-Native Blue = Special Status Species					

Figure 10.3. El Segundo blue butterfly, *E. battoides allyni*, observed in the western dunes habitat of the BWER (photo: Dan Cooper, 2011).

ANALYSIS OF BASELINE RESULTS

Identical methods were employed across both baseline years to achieve consistent and scientifically comparable results.   Additionally, the same transect locations were repeated, with several additional transects added in the second baseline year to assess a larger data set congruent with vegetation surveys. Consistency will allow for the future evaluation of long-term patterns in the aerial invertebrate community across multiple years. Additionally, similar methods are being employed at several other southern California wetlands. This will allow for future regional and long-term comparisons across a variety of wetlands and habitat types.

The large seasonal variability in arthropod biomass makes comparison across years difficult. Constrained access to certain regions of the BWER due to nesting sensitive species makes sampling aerial arthropod productivity during peak arthropod biomass/productivity (late spring/early summer) difficult. As a result, some habitat types were assessed across multiple seasons (e.g. seasonal wetland) or at slightly different times of year (e.g. upland grassland) and this may have resulted in a higher degree of variability between the transects (reflected as high standard error in Figure 10.1) and between years. This variability will be addressed in the future by timing the invertebrate surveys consistently within each habitat type based on the appropriate flowering season of the vegetation alliances where possible. Additionally, abiotic conditions will be noted to account for further potential causes of variance.

The productivity metric is appropriate to evaluate invertebrate size class proportion productivity (metric described in this Chapter) or overall aerial arthropod biomass between sites (future analyses). However, there are many terrestrial, land-based invertebrate species for which this survey method is not appropriate (e.g. isopods, ants, some beetles, etc). This data gap will be addressed in the third year monitoring report through invertebrate pitfall surveys for terrestrial land invertebrates. Pitfall surveys began in the second baseline year throughout the BWER and will be continued in year three and included in next year's annual report.

FUTURE DIRECTIONS

Aerial arthropod surveys will continue in the third Baseline year. Although pitfall trapping may not be an effective method to determine actual terrestrial insect population sizes and abundances, it can be effective as both a relative comparison between sites and as an indicator of species presence. Species-level terrestrial surveys will be conducted in the third Baseline year utilizing pitfall traps. Voucher specimens of each species will be taxonomically identified. Pitfall traps will be deployed in the same locations and times as the aerial arthropod surveys and will be compared by habitat.

APPENDIX I.1

Special status terrestrial invertebrate species with the potential to inhabit the Ballona Wetlands Ecological Reserve

Common Name	Species Name	Conservation Status in California
Belkin's dune tabanid fly	*Brennania belkini*	IUCN: Vulnerable; NatureServe: S1, S2
Dorothy's El Segundo dune weevil	*Trigonoscuta dorothea dorothea*	NatureServe: S1
El Segundo blue butterfly	*Euphilotes battoides allyni*	Federally Endangered; NatureServe: S1
Globose dune beetle	*Coelus globosus*	IUCN: Vulnerable; Nature Serve: S1
Hairy-necked Tiger Beetle	*Cicindela hirticollis gravida*	NatureServe: S1
Lange's El Segundo dune weevil	*Onychobaris langei*	NatureServe: S1
Monarch butterfly	*Danaus plexippus*	NatureServe: S3
Quino checkerspot butterfly	*Euphydryas editha quino*	Federally Endangered; NatureServe: S1
Riverside fairy shrimp	*Streptocephalus woottoni*	Federally Endangered; NatureServe: S1; IUCN: Endangered
San Diego fairy shrimp	*Branchinecta sandiegonensis*	Federally Endangered; NatureServe: S1; IUCN: Endangered
Wandering skipper	*Panoquina errans*	IUCN: Near Threatened; NatureServe: S1
Western mudflat tiger beetle	*Cicindela trifasciata sigmoidea*	NatureServe: SNR

NatureServe Conservation Rank Definitions

The conservation status of a species or ecosystem is designated by a number from 1 to 5, preceded by a letter reflecting the appropriate geographic scale of the assessment (G = Global, N = National, and S = Subnational). The numbers have the following meaning: 1 = critically imperiled, 2 = imperiled, 3 = vulnerable, 4 = apparently secure, 5 = secure. SNR = Unranked

NOTE: Taxonomic nomenclature is from the Integrated Taxonomic Information System (ITIS; http://www.itis.gov/, searched January 2011).

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PHYSICAL CHARACTERISTICS
Baseline Assessment Program: 2010-2011 Report

CHAPTER 11:
PHYSICAL CHARACTERISTICS

Ballona Wetlands Ecological Reserve, Los Angeles, California
Santa Monica Bay Restoration Commission

Prepared for: California State Coastal Conservancy
June 2012

Author: Karina Johnston

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PHYSICAL CHARACTERISTICS

INTRODUCTION

Many of the biological and chemical processes that occur in wetlands are driven by the physical and hydrologic characteristics of the site (Nordby and Zedler 1991, Williams and Zedler 1999, Zedler 2001). Physical surveys of hydrology, topography, and tidal inundation regimes (Zedler 2001, PWA 2006) can be used to assess temporal changes to a site, including erosion and sedimentation.

The goals of the second year physical characteristic surveys of the Baseline Assessment Program (BAP) included:

1) Assess the aerial extent of inundation within muted tidal areas;
2) Survey channel cross-sections to assess profile changes over time; and
3) Determine average elevations across transects within specific habitat types.

METHODS

Three types of surveys were conducted during the second Baseline year to assess the physical characteristics of the BWER including: inundation and cross-section surveys to assess the muted tidal habitats of Area B, and reserve-wide elevation surveys by habitat type.

Inundation Surveys

Inundation within the salt marsh of the BWER was mapped several times during a high spring tide event (Table 11.1) using a Trimble Geo XH GPS unit. All tidal channels throughout Area B of the BWER north of Culver Boulevard were surveyed by following the outline of inundation. Three of the resulting tracks and data were linked to current aerials of the BWER through GIS to develop a complete inundation map.

Table 11.1. Inundation track survey time and tide height details (NOAA, Santa Monica tide gauge, MLLW).

Date	Survey Time	Tide Height Range During Survey (m)
7/20/2011	1230 - 1530	1.31 to 1.27
7/25/2011	1630 - 1930	1.53 to 1.55
7/26/2011	1730 - 2030	1.66 to 1.61
7/27/2011	1300 - 1700	0.77 to 1.27
8/2/2011	900 - 1230	0.97 to 1.55
8/8/2011	1630 - 2000	1.72 to 1.62
8/11/2011	830 - 1200	1.27 to 1.02

Channel Cross-Section Surveys

Channel cross-sections were surveyed within the tidal channels of Area B and the Fiji Ditch (Figure 11.1) during the summer of 2011 on a subset of the same permanent survey locations from the PWA 2006 survey (PWA 2006). A survey tape was attached to station endpoint pins on the right and left banks and stretched taut. Using a level transit and stadia rod, measurements were taken every 50 cm and at every break in slope. Distance and elevation data were recorded on a datasheet. Elevation data were surveyed in the National Geodetic Vertical Datum of 1929 (NGVD 1929; adjusted 1985).

Figure 11.1. Map of cross-section survey locations in the Fiji Ditch in Area A (A) and the tide channels of Area B (B) within the BWER.

Elevation Surveys

Elevation surveys were completed on the same subset of vegetation transects used for soil, terrestrial invertebrates, and seed bank surveys (see Ch. 4, Vegetation, Johnston et al. 2011). The surveys used U.S. Geological Survey (USGS) benchmarks provided by the City of Los Angeles (Bureau of Engineering) and other published benchmarks and included measurements every 5 meters along each 25-meter transect, for a total of 5 elevation points per transect. Data were analyzed using NGVD 1929. Benchmark leveling (vertical control survey) was conducted using a Trimble GPS, tilting level, a tripod and No. 1 SK rod (ft), 10ths and 100ths.

For details regarding the functionality of the self-regulating tide gates along the Ballona Creek levee in Area B, refer to Chapter 11 of the first year Baseline Report (Johnston et al. 2011).

RESULTS

Results indicate that the BWER has a highly atypical hydrological system when compared to southern California perennial estuarine wetlands; the tide gates create a muted tidal regime with relatively low inundation across the tidal habitats (see Inundation results below).

Additional physical surveys and previous assessments identified areas of fill and dredge spoils (DFG 2007). These areas were significantly altered from historic elevation and soil characteristics (e.g. elevation above mean sea level, texture, grain size, etc). Elevation surveys indicate several clear groups of habitat types (see Elevation results below).

Inundation

The total aerial surface area of inundation within Area B of the BWER was 5.95 acres, or approximately 1% of the total BWER area (600 acres). The acreage was determined by converting the three most complete tracks during high tides (Table 11.2) into a connected polygon (Figure 11.2) using ArcGIS and calculating the total surface area within the polygon. Note that this is an aerial inundation value only and does not account for surface slope or microtopographic heterogeneity. These results also varied by tide height and the point that the tide gate closed on individual tides. Figure 11.2 displays the most complete map based on three of the surveys following independent tracks (i.e. Track 1, 2, and 3; Figure 11.2). Inundation was mapped along each track during several additional tide heights not represented on Figure 11.2.

Appendix I.1 illustrates the wetland areas delineated as United States Army Corps of Engineers (ACoE) Jurisdictional Areas (green) (WRA 2011). The total area of designated wetlands includes 153.2 acres, or approximately 25% of the reserve, primarily located in Area B. The majority of the wetland delineated habitats (Appendix I.1) are non-tidal, saline, seasonal wetlands formed through the presence of salty soils and inundation via stormwater. They do not exhibit the full mixed semi-diurnal tidal inundation regime typically represented by fully tidal estuarine systems in southern California (or bar-built estuaries during open periods), but instead include hydrological characteristics similar to depressional, non-tidal wetlands. These non-tidal saline wetlands, or seasonal wetlands, account for the vast majority of the wetland habitat types within the BWER. ACoE designated 'non-wetland waters', which encompass 83 acres across the BWER, including: Ballona Creek, salt pan habitats, and the tidal channels.

Table 11.2. Details for three full surveys conducted in the summer of 2011 during similar tide heights (NOAA, Santa Monica tide gauge, MLLW).

Track #	Date	Survey Time	Tide Height (m)	Color
Track 1	07/20/2011	1230 – 1530	1.31 to 1.27	Orange
Track 2	07/26/2011	1730 – 2030	1.66 to 1.61	Green
Track 3	08/08/2011	1630 – 2000	1.72 to 1.62	Blue

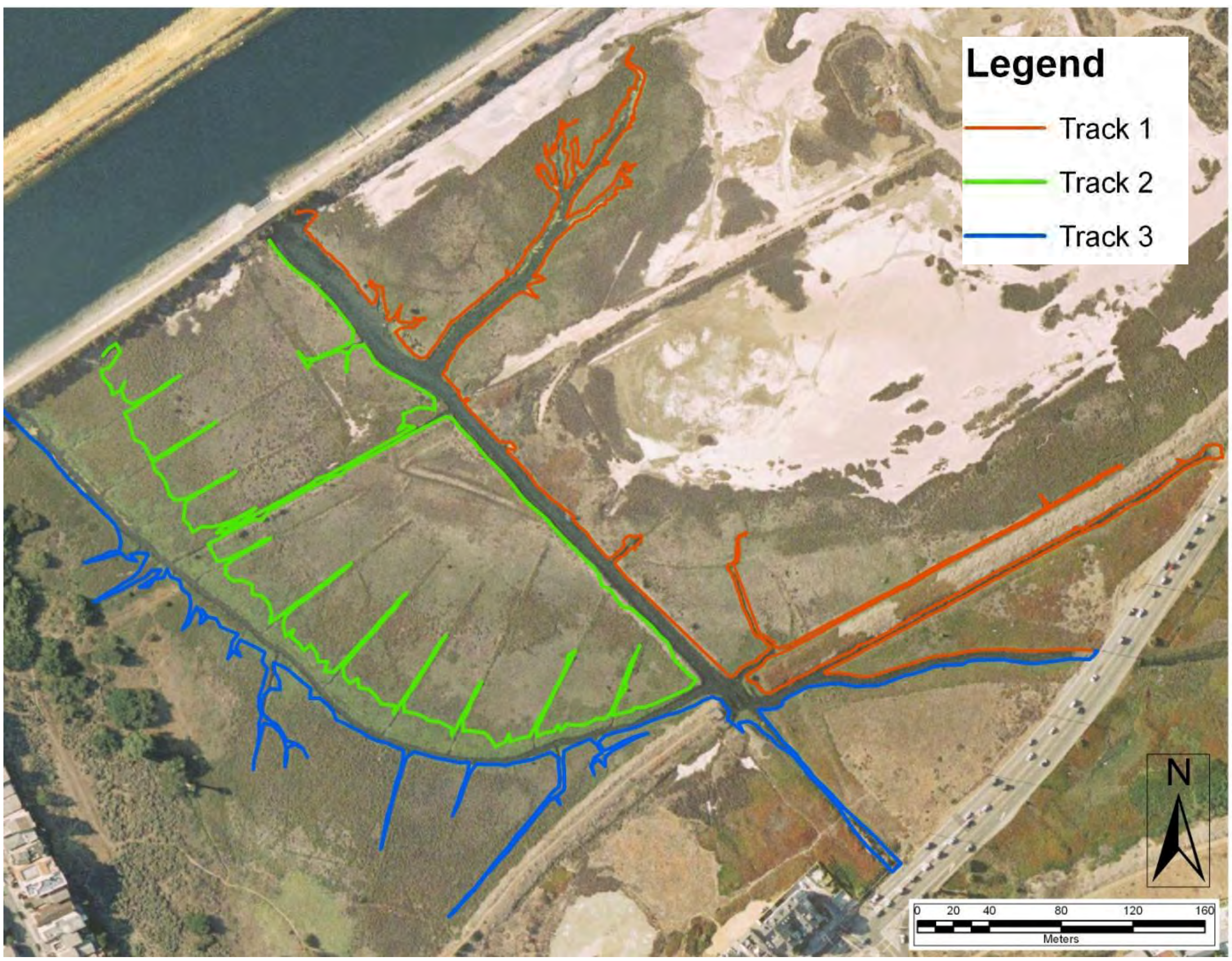


Figure 11.2. Inundation track map displaying data from three mapping days along tracks in different areas corresponding to details in Table 11.2.

Cross-section Results

The cross-section surveys showed steep channel banks often surrounded by an upland berm. Individual cross-sections varied based on location, but all expressed a similar overall pattern. Figure 11.3 displays the cross-section data for the main (eastern) tide gate channel and approximately 25 meters to either side of the channel. Figure 11.4 displays the cross-section data for the outflow (western) tide gate channel and approximately 15 meters to either side of the channel.

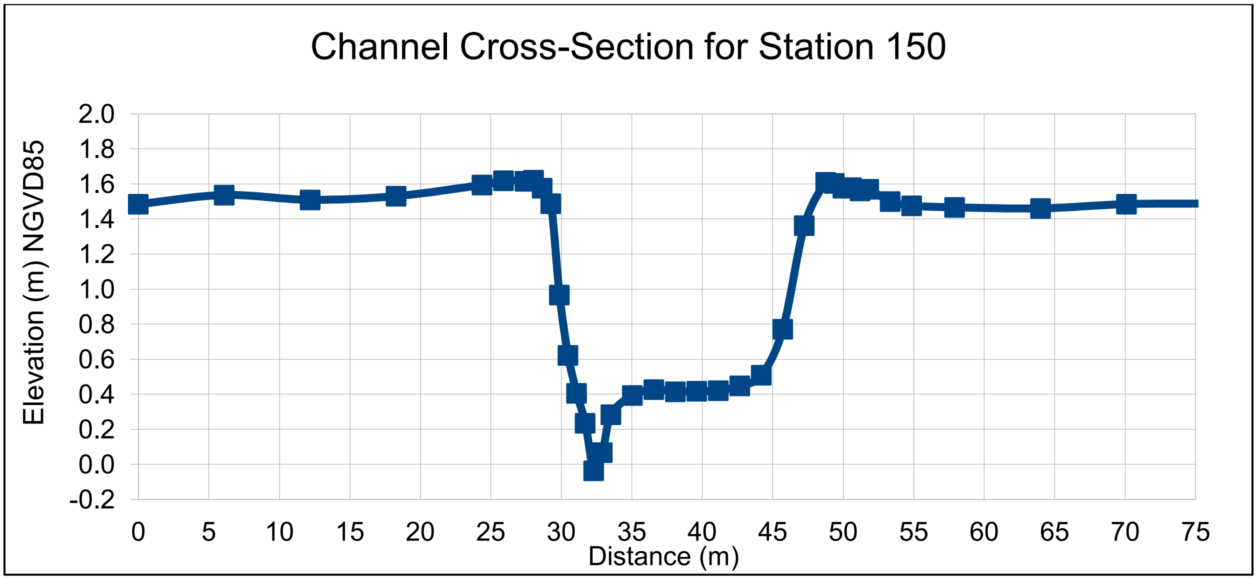


Figure 11.3. Channel cross-section for Station 150 in the main (eastern) tide channel of Area B of the BWER. Elevation (m) is represented by the NGVD29 datum.

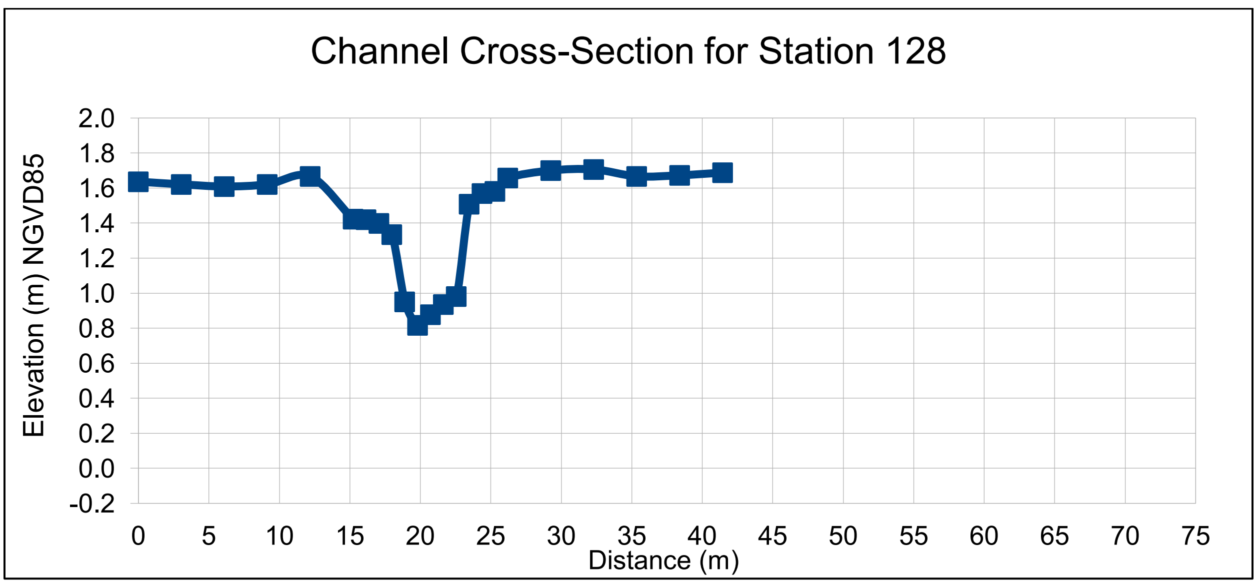


Figure 11.4. Channel cross-section for Station 128 in the outflow (western) tide channel of Area B of the BWER. Elevation (m) is represented by the NGVD29 datum.

Elevation Results

As expected, the upland habitat types had higher overall average elevations than did the lower marsh habitat types when assessed by transect averages (Figure 11.5). However, the low marsh (1.78 m) habitat actually had approximately the same average elevation as the mid marsh (1.52 m), high marsh (1.55 m), salt pan (1.72 m), and seasonal wetland (1.80 m) (Figure 11.5). Habitats were defined primarily by vegetation alliances based on California Department of Fish and Game surveys in 2007 (DFG 2007). The error, or variation between transects, was the highest in the upland scrub, seasonal wetland, and brackish marsh.

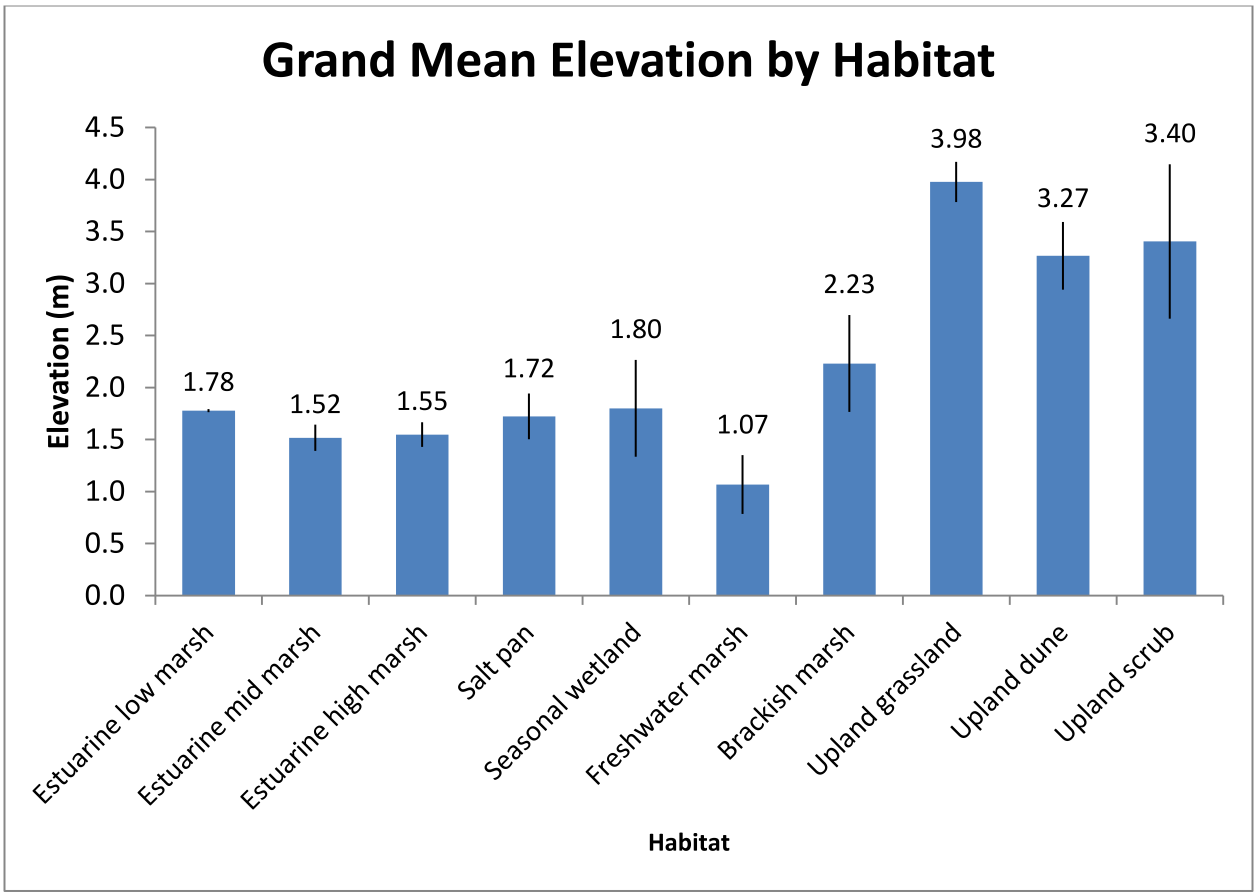


Figure 11.5. Grand mean elevation (m) by habitat type.

Climate Results

Climate data were obtained from the National Oceanic Atmospheric Administration (NOAA) Western Regional Climate Center using a nearby long term weather station to the BWER at the Los Angeles International Airport (http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?calosa). Total precipitation was 34.16 cm during the second Baseline year (from September 2010 through September 2011) with most rainfall occurring during December (Figure 11.6).

The mean sea level trend in the Los Angeles, California region is a rise of 0.83 mm/yr with a 95% confidence interval of ± 0.27 mm/yr based on monthly mean sea level data (NOAA 2011).

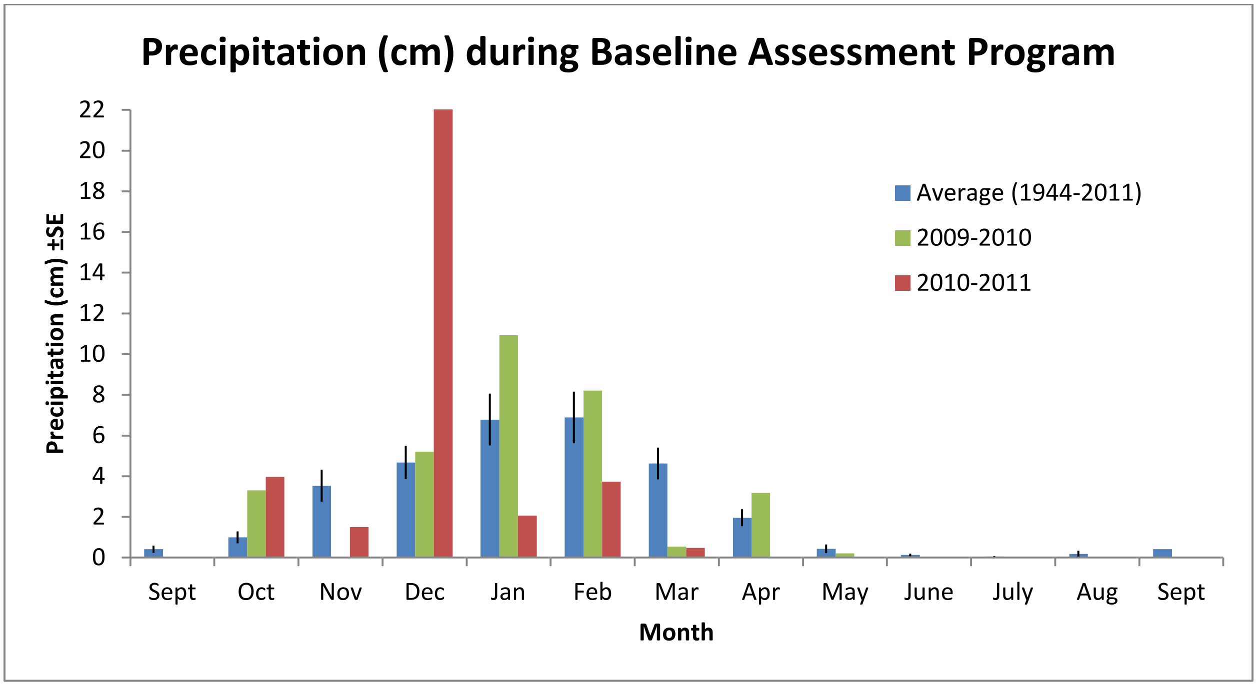


Figure 11.6. Precipitation throughout both Baseline years and the average rainfall from 1944-2011 (data from the Los Angeles International Airport rain gauge (http://www.cnrfc.noaa.gov, accessed May 2012).

ANALYSIS OF BASELINE RESULTS

In addition to assessing the hydrological functioning of a system, physical surveys also determine characteristics and limitations that influence the flora and fauna of the surrounding habitats (Eicher 1987, Zedler et al. 1999). The inundation and cross-section data together indicate a highly modified wetland system that has very little marsh plain regularly inundated by tides, and steep tide channel banks surrounded by a berm indicative of a disturbed or anthropogenically modified system. Most of the cross-section surveys indicate high adjacent habitat areas and elevations, typical of a high marsh system, rather than a low marsh or mid-marsh system. The inundation results support the conclusion in that only a small portion of the marsh habitats are regularly inundated.

Low levels of inundation may be limiting habitat types in the marsh system (e.g. mudflat, low marsh, mid marsh, etc). Further analyses of the species distribution of vegetation alliances in relation to the inundated areas could determine how the modified elevation gradients and muted tidal regime may be affecting the vegetation communities.

The grouping of the elevation data (i.e. the similar average heights for the marsh habitats) indicate that either the transects sampled were not representative of the whole habitat, or that the habitat delineations (DFG 2007) were based primarily on vegetation alliances and not on elevations. For example, the average low marsh habitat elevation was higher than both the mid and high marsh.

In conclusion, impacts, stressors, and anthropogenic modifications to the BWER over time have altered wetland habitats when assessed through physical characteristics. Some functions of estuarine wetland habitats remain, in that there are still muted tidal conditions and saline soils supporting salt marsh vegetation; although many characteristics of tidal wetlands (gradual, sloping banks, large areas of inundation on high spring tides) are absent. Further analyses are suggested, including assessing the current (2011) cross-sectional data against the data collected in 2006 (PWA 2006).

FUTURE DIRECTIONS

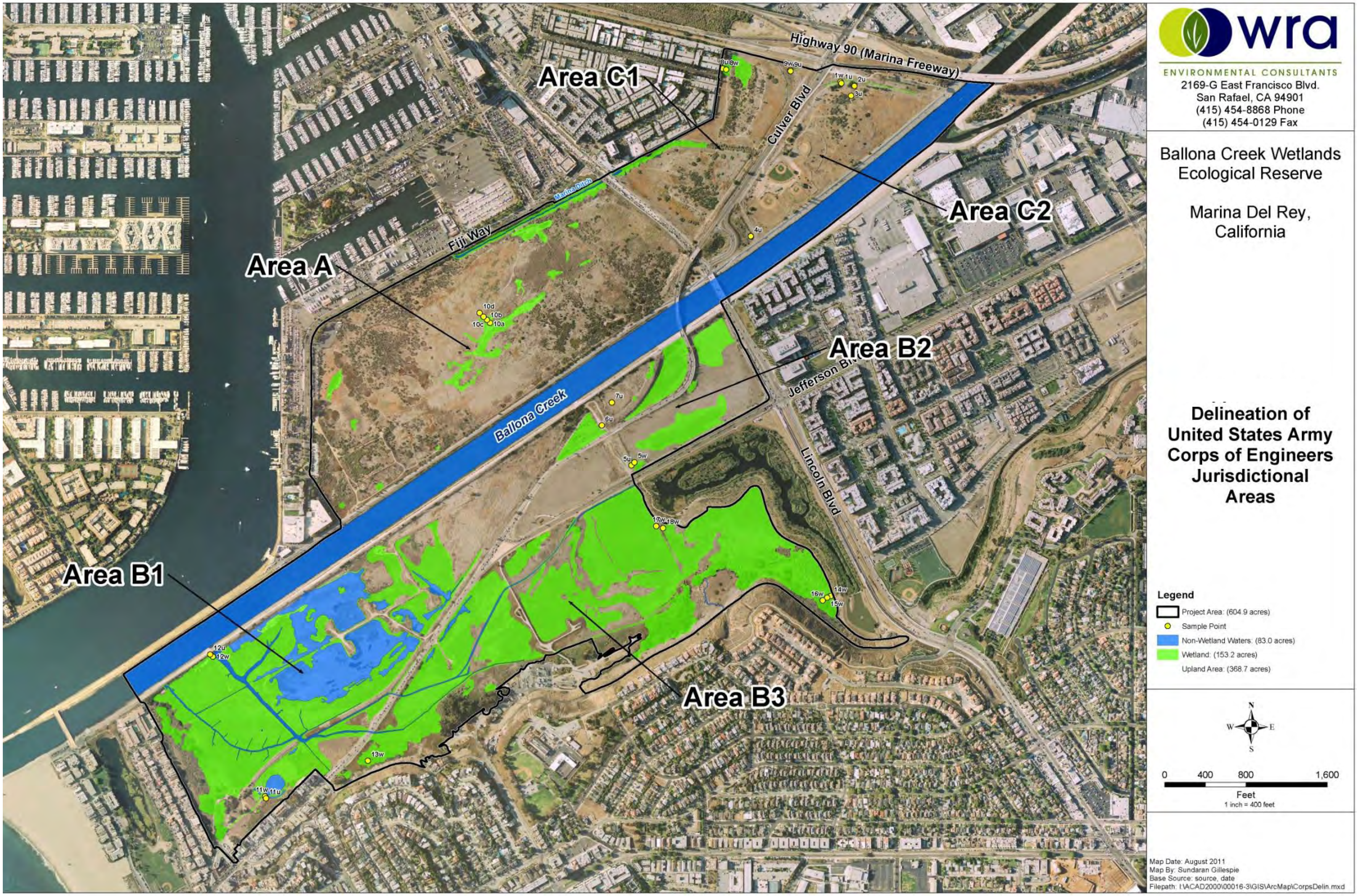
Physical surveys will continue opportunistically in the third year of monitoring. Targeted surveys for velocity, mass balances of water and contaminants, and inundation will continue in partnership with the engineering department of Loyola Marymount University.

Sea-Level Rise Study

The Center for Santa Monica Bay Studies, a joint program of Loyola Marymount University and the Santa Monica Bay Restoration Commission, conducted a study on the effects of climate change on the Ballona Creek Watershed and the BWER. This study was based on theoretical modeling of sea-level rise scenarios based on current data. Modeling included projected scenarios such as improved watershed management and restoration projects. The full report will be available electronically (Summer 2012; www.ballonarestoration.org).

APPENDIX J.1

Delineation of United States Army Corps of Engineers Jurisdictional Wetland Areas in the Ballona Wetlands Ecological Reserve (WRA 2011)



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